THE

# FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 49. Thursday, February 9, 1933. No. 860.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (5 lines).

## Contents.

| | PAGE |
|---|---|
| Forthcoming Events | 101 |
| An Optimistic Forecast | 101 |
| Anti-Foundry Propaganda | 101 |
| The Presto Sand Mixer | 102 |
| A New High-Temperature Gas-Fired Furnace | 102 |
| Random Shots | 102 |
| Phosphorus in Cast Iron | 103 |
| Aluminium Bronze | 106 |
| Notes on Some Common Defects in Steel Castings | 108 |
| International Iron and Steel Standards | 110 |
| Foundry Costing | 111 |
| Drilling Square Holes in Castings | 112 |
| The Scrap-Metal Position | 113 |
| Electric Drive v. Gas Engine | 113 |
| More Christmas Presents | 113 |
| Trade Talk | 114 |
| Obituary | 114 |
| Personal | 114 |
| Raw Material Markets | 116 |

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

*Institute of British Foundrymen.*

PRESIDENT: 1932-33:
Victor Stobie, M.I.E.E., Langholm, South Drive, Harrogate.

LIST OF SECRETARIES—
General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office: 49, Wellington Street, London, W.C.2.
Birmingham, Coventry and West Midlands: L. W. Bolton, 21-23, St. Paul's Square, Birmingham.
Sheffield: T. R. Walker, 33, Ladysmith Avenue, Nether Edge, Sheffield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
Lancashire: J. E. Cooke, 1, Derbyshire Crescent, Stretford, Manchester.
London: H. W. Lockwood, Stewarts & Lloyds, Limited, Winchester House, Old Broad Street, London, E.C.2.
Newcastle-upon-Tyne: J. W. Eckford, 4, Mosley Street, Newcastle-upon-Tyne.
East Midlands: H. Bunting, 82, Otter Street, Derby.
West Riding of Yorkshire: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.
Wales and Monmouth: J. J. McClelland, 12, Clifton Place, Stow Hill, Newport, Mon.
Middlesbrough: F. A. Harper, "The Briars," Bishopton Road, Stockton-on-Tees.

*Foundry Trades' Equipment and Supplies Association.*

President: D. H. Wood,
Titan Works, Charles Henry Street, Birmingham.
Secretary: K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2.

*Welsh Engineers' and Founders' Association.*

Secretary: E. J. Griffiths, 2, Royal Metal Exchange, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION
The Registered Office and Laboratories of the B.C.I.R.A. at:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM.
*Telephone: Central 1885. Telegrams: CIRA.*
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Telephone 332*).

## Forthcoming Events.

FEBRUARY 15.

*Institution of Welding Engineers (London Section)*:—Ordinary meeting. "Where Oxy-Acetylene and Electric Welding Join Forces," Paper by O. Simonis.

FEBRUARY 17.

*Institution of Welding Engineers (Birmingham Section)*:—Ordinary meeting. "The Metallographic Examination of Welds, Paper by J. D. Jevons and M. A. Wheeler.

**Institute of British Foundrymen.**

FEBRUARY 9.

*Lancashire Branch (Burnley Section)*:—Ordinary meeting. "Making a Cloth Roller for Printing Machine," Paper by W. H. Meadowcroft.

*London Branch*:—Ordinary meeting. "Mechanical Handling in the Foundry," Paper by A. W. G. Bagshawe.

FEBRUARY 10.

*Middlesbrough Branch*:—Ordinary meeting. "The Wear of Cast Iron," Paper by F. K. Neath.

FEBRUARY 11.

*West Riding of Yorkshire Branch*:—Ordinary meeting. "Cause and Effect in the Bronze Foundry," Paper by F. W. Rowe, B.Sc.

*Newcastle-upon-Tyne Branch*:—Annual dinner.

FEBRUARY 17.

*Sheffield and District Branch*:—Ordinary meeting. "Mechanised Core Shops," Paper by H. F. Coggon.

FEBRUARY 18.

*Lancashire Branch*:—Ordinary meeting. "Some Practical Non-Ferrous Foundry Work," Paper by F. Dunleavy.

*Lancashire Branch (Junior Section)*:—"Some First Principles in Foundry Practice," Paper by A. Jackson.

## An Optimistic Forecast.

It is now possible to see how the production of pig-iron and steel compares for 1932 with 1931. More than any other statistics these figures show how the country is weathering the depression. The output of pig-iron in 1932—3,573,000 tons—was only 5.5 per cent. less than in 1931. The production of steel—just over 5¼ million tons—is actually 1 per cent. more than 1931. At the bottom of a curve of depression the rate of change is very slight, and it is usually only possible to see whether a trend is definitely upward or downward after a period of time. There seems to be little doubt that it is now upward. The British iron and steel industry has, of course, been in a deplorably bad way for some years, but the figures quoted above afford great cause for satisfaction when it is remembered that the world production for pig-iron in 1932—38¾ million tons—was about one-third below 1931, and the steel output, slightly in excess of 49 million tons, was 28 per cent. less than 1931. There has thus been an enormous shrinkage in the output of other countries, and this, indeed, is largely responsible for the present industrial conditions in America and Germany. The decline in the United States was just over half for pig-iron and nearly half for steel; the decline in the German production again comparing 1932 with 1931, was 3 per cent. for pig-iron and 31 per cent. for steel; the corresponding French declines were 32 per cent. and 29 per cent.

Examination of the import position discloses that we imported in 1931 over 2¾ million tons of ferrous material, this being well in excess of the 1913 figure. In 1932 the figure was only slightly in excess of 1½ million tons, and it must be borne in mind that the 10 per cent. revenue tariff was only applied on March 1 and raised to the 33⅓ per cent. figure at the end of April. It is evident that the tariff has been of very great assistance in checking imported material which can be produced here.

Taking the export figures, in 1931 we exported nearly two million tons of ferrous products, considerably less than half the 1913 figure; in 1932 this had fallen to 1.9 millions. While there is a fall, it is very slight, and not comparable with the reduction in imports. There is, therefore, no doubt that the trade balance, so far as iron and steel production is concerned, has greatly improved.

Considering individual items of interest to the foundry trade, imports of pig-iron were in 1932 half the 1931 figure, while cast pipes were cut to about one-quarter, as also were castings in the rough state. The exports of pig-iron fell materially, but the drop in the export of cast-iron pipes was comparatively slight. The year 1933, therefore, began on an optimistic note. The stocks of imported material brought in before the tariff are gradually being absorbed.

## Anti-Foundry Propaganda.

We recently drew attention to an article in "The Times Engineering Supplement," which all but wrote the epitaph of the once-prosperous foundry industry. Now Mr. H. E. Yerbury, M.I.C.E., has used the correspondence columns of "The Engineer" to inform the world that "During a recent visit to Canada and America he was impressed by the fact that steel foundries are almost a thing of the past" and that "drop forgings and stampings and general fabricated work have taken their place." He goes on to say that "Large arc-welding plants are installed in all the works of any magnitude and that the framework of motors, generators and turbines, large and small, are now being built up of standard steel sections, etc., and welded into the desired shapes." We should have thought that an engineer of Mr. Yerbury's undoubted eminence would have realised that none of the jobs he cites is normally made as a steel casting. It is essential that the foundry industry combat by every means at its disposal this constant reiteration of unsubstantiated generalisations. Our information is that the day of welded casings for small motors is past and that after a very short life the manufacturers have reverted to cast iron. So far as the big constructions are concerned, the time factor has not yet operated sufficiently long to produce data. But we expect that there will come to light cases of failure due to stress-concentration causing fatigue cracks—a phenomenon virtually impossible with cast iron owing to the cushioning effect of the graphite content. The strength of steel castings at high temperatures and pres-



XUM

sures is still insufficiently appreciated by the majority of engineers, whilst there seems to be a positive conspiracy amongst them to forget the wonderful corrosion-resisting properties of cast iron. Finally, we can assure Mr. Yerbury that it is not competition from other products which has caused the present position in the steel-founding industry, but the unfortunate and indiscriminate erection of new and expansion of existing steel foundries during the war period and immediately afterwards. Members of the foundry industry must in future join us in using every endeavour to combat the effect of loose statements in the technical Press which are adverse to the interests of the foundry industry as a whole.

## A New High-Temperature Gas-Fired Furnace.

### CLAIMS WORKING TEMPERATURE OF 2,000 DEG. C.

We have had brought to our notice by Messrs. Bush, Beach & Gent, Limited, of Marlow House, Lloyd's Avenue, London, E.C.3, the existence of a novel type of town's gas-fired furnace of German origin for which claims of an outstanding character are made. The literature examined passes in review the surface-combustion principle devised by Prof. Bone. It indicates that certain shortcomings may be encountered in the practical application of the process and it is stated that the defects they indicate may be overcome by using unmixed gases prior to entering the furnace and by a maximum reduction of the resistance to the gases passing through the furnace.

The new furnace is provided with an internal lining of magnesia or zirconium oxide. All the refractory parts are in the form of segments which are dove-tailed and provided with special bosses in order to ensure better support. In general, segments have longer life and are cheaper to manufacture and more convenient to replace than are large masses. The type of furnace now being manufactured is shown in cross section in Fig. 1.

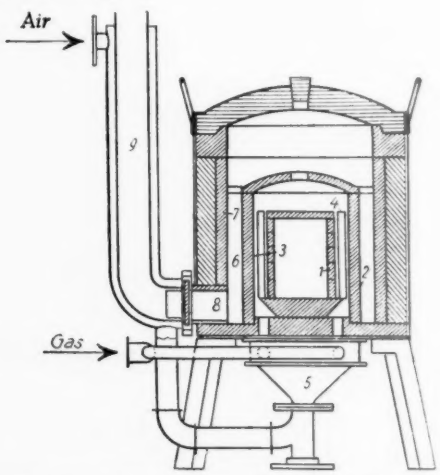



Fig. 1.—The Degussa High-Temperature Furnace for which a Temperature of 2,000 deg. C. is claimed.

The internal working space (1) is concentrically surrounded by a shell (2). The comparatively-narrow intervening space (3) between these casings is the actual combustion chamber. In order to increase the surface accelerations the combustion by the catalytic contact effect, tubes (4) are put in this combustion chamber loosely and parallel to the gas current. The enlargement of the effective surface is thus attained without materially increasing the resistance within the furnace.

The gases (*e.g.*, air and coal gas) leaving the burner (5) separately, which is fixed in the centre, are not mixed until they enter the combustion chamber, where they are at once ignited; back-firing is thus impossible. After passing through the combustion chamber the wasted gases are conducted down into cool air (6) between the shell (2) and the lining (7) of the furnace in order to be conveyed out through the lower opening (8) to the chimney (9). This style of "double-flame conduction" ensures a more complete utilisation of the heat contained in the combustion gases than is effected by "single-flame conduction," by means of which the heat is conducted direct out of the combustion zone into the chimney. The hot waste gases are utilised in a double-walled pipe to heat the fresh air on the counter-current principle.

The advantages claimed for this furnace are stated to be that (1) it works with the ordinary pressure of the coal-gas supply from the main; (2) an ordinary low-pressure fan only is required; (3) allows of working with any desired atmosphere—reducing, neutral or oxidising; (4) under suitable conditions, with coal gas, 2,000 deg. C. is attained with certainty; (5) the distribution of temperature in the furnace proper is more uniform than in any other furnace; and (6) the furnace proper available is greater considering the consumption of energy than with other furnaces.

## The Presto Sand Mixer.

British Foundry Units, Limited, of Retort Works, Chesterfield, have designed and placed on the market a counter-current sand mixer. The pan is stationary, and is filled with renewable steel segments. For effecting the mixing the following components are involved:—a revolving star with three adjustable mixing blades; a kneading roller cast in close grained iron with a chilled tread, and two rolled steel-directing ploughs. The details are shown in

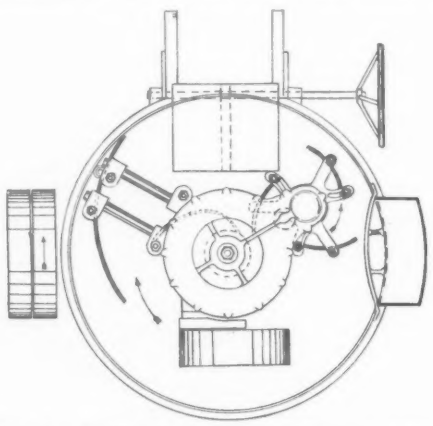


Fig. 1.—Shows in Section the Details of the Presto Sand Mixer.

Fig. 1. The main drive is through bevel gears and the mixing components through machine-cut gears running in a totally-enclosed case.

The discharge of the mixed material is by means of a hand-operated sliding door in the pan bottom. The bearings are of the loose ring self-oiling type, whilst the bearings run in an oil bath. Other parts are lubricated by the grease gun method.

## Foundry Query.

The writer is experiencing considerable difficulty in casting 14 in. long by 4 in. dia. chilled cast-iron rollers, and would be obliged if any of your readers could give information as to the best method of eliminating pinholes, porosity, dirty places, etc., and how to ensure a clean and even surface.

## Random Shots.

Birmingham, the birthplace of the I.B.F. and other good things, revealed itself in happy mood at its Branch's Annual Dinner some days ago. Vaunting its progressive outlook, it graced its festivity by the presence of members' ladies. The chief guest, drawn to express himself thereon, gave a tale of the man who, on his demise, went to Hades to look for an old flame. He was met by his Satanic Majesty, who told him: "We have no women here. This is HELL!"

* * *

The responder to the toast of "The Guests" gave the Institute credit—such was then the late hour—for being some 7,000 years old! He tempered the praises he sang by suggesting that when the electric-motor industry—of which he is a shining light—has gone 7,000 years, it will put the foundry business to shame for progress. Relying on a well-known advertisement, we would ask him if certain motors are guaranteed for the residue of the term?

* * *

One speaker, who, to defeat reprisals, shall be code-less, had listened to previous speakers and delivered himself to the effect that speeches would be best abolished; not that he minded speaking himself, dear me, no! but his sympathies were undoubtedly with the audience! Forgivingly, he was much applauded by the other speakers.

* * *

To wind up a most enjoyable and enlightening evening, a well-known veteran of the Institute dished us up the savoury secret: "You can tell a Birmingham girl anywhere, but you can't tell her much."

And we know he never repeats hearsay!

* * *

Birmingham is, undoubtedly, well placed near to Worcestershire.

* * *

Speaking of the Black Country (!) the question is being asked: "Why is Cradley Heath not a member of the International Society for Testing Materials?" This, of course, is very sub-tell. For those who are least aware of it, I would say that Cradley Heath is not anybody's brother, but is a local township where the majority of chains born in this country are hatched. Its qualification for membership of the I.S.T.M. is, it appears, its discovery of the now standard test for chains as practised in all the best *milieux*, consisting of testing if the chain will successfully resist, without sign of disintegration, being pulled across the road from the factory to the despatch shed. No lubricant is allowed the tester or the tested. The outcome of the test is recorded sometimes after and sometimes before the test, usually either; and a certificate is destroyed with each consignment.

The previous practice of testing a chain to destruction, by applying the load for which it was built, was said to be not satisfactory.

* * *

Two questions I forgot to put to the Lord Mayor of Birmingham were:—

Is Birmingham's interest in Warstock what it used to be?

Is Corporation Street so named because that body seems always in possession?

* * *

Consideration for others is, above all things, the keynote of the Midlands. Should one show signs of fatigue in argument, one is advised to go to Coventry; presumably, because it is a healthier district for one's nerves. But we are now told that gambling is rife in that town. Lady Godiva, who lived about 850 Before Wireless, put all she had on a horse.

Marksman.

# Phosphorus in Cast Iron.

By W. West (Leyland Motors, Limited).

(*Continued from page* 90.)

### Porosity.—Test I.

For this experiment a cruciform section of test-piece was used having the shape and size as represented by Fig. 1. The mould was of green sand, fairly dry, and poured with the cruciform section in the top part. The castings were allowed to cool in the mould, and when cold the section at the base of the pillar was sectioned horizontally and vertically.

### Porosity.—Test II.

At the suggestion of Mr. P. A. Russell, chairman of the Cast Iron Sub-Committee of the Technical Committee of the Institute of British Foundrymen, two sets of solid blocks were cast, one series without feeding heads, and the other with feeding heads. The blocks were 3½ in. wide, 4 in. long, 3 in. deep, and cast in dry-sand moulds (Fig. 2). In the top face of the block two holes were drilled, 1½ in. dia. by 2½ in. deep, ⅝ in. apart. Each hole was threaded at its mouth for a sufficient distance to enable a water connection to be attached. Each hole had water pressure applied to 500 lbs. per sq. in. separately, any leakage through the ⅝-in. partition was noted in the other hole. This test, detailed in Table II and III, was extremely searching insomuch that the partition of metal between the holes represented the centre of the block.

### Effect of Phosphorus on Tensile Strength.

Round test-bars of varying diameters to the B.S.I. specification requirements were cast on end in oil-sand cores, the metal being run in at the top of the mould, and provided with head metal to ensure soundness. The results are shown in Tables V, VI and VII.

### Effect of Phosphorus on Transverse Strength.

Standard test-pieces of three sizes were cast on end in a similar way to the tensile pieces. The results have been corrected for any inaccuracy in dimension at the point of fracture, and are given in Table VIII. The range of compositions of the irons is common to the set of three tests, and is indicated by test numbers.

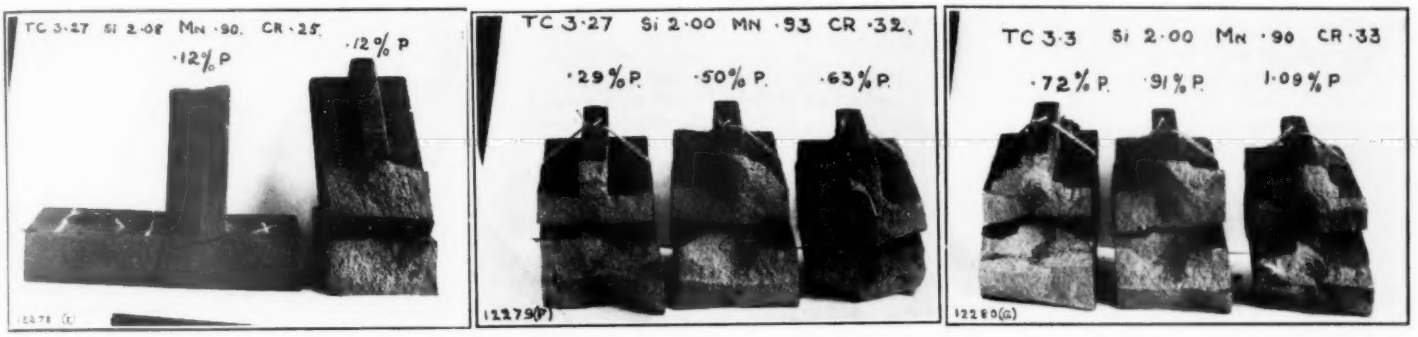



FIG. 1.—TYPE OF TEST-PIECE USED AND THE INFLUENCE OF PHOSPHORUS ON FRACTURE.

TABLE I.—*Composition and Fracture of Phosphorus Series.*

| Analysis. | | | | | | Pressure test results. |
|---|---|---|---|---|---|---|
| T.C. | Si. | Mn. | S. | P. | Cr. | |
| 3.27 | 2.08 | 0.91 | 0.045 | 0.12 | 0.27 | Sound in fracture. |
| 3.36 | 2.10 | 0.92 | 0.060 | 0.15 | 0.33 | Sound in fracture. |
| 3.30 | 2.00 | 0.90 | 0.040 | 0.24 | 0.30 | Sound in fracture. |
| 3.27 | 2.10 | 0.93 | 0.036 | 0.29 | 0.32 | Traces of sponginess. |
| 3.35 | 2.04 | 0.89 | 0.050 | 0.36 | 0.31 | Traces of sponginess. |
| 3.30 | 2.10 | 0.82 | 0.055 | 0.50 | 0.40 | Definite spongy patch. |
| 3.35 | 2.04 | 0.86 | 0.048 | 0.63 | 0.36 | Large and definite spongy patch. |
| 3.36 | 2.10 | 0.90 | 0.060 | 0.72 | 0.32 | Large and definite spongy patch. |
| 3.30 | 2.12 | 0.80 | 0.055 | 0.78 | 0.36 | Increased spread of spongy patch. |
| 3.24 | 2.12 | 0.75 | 0.060 | 0.91 | 0.42 | Increased spread of spongy patch. |
| 3.24 | 2.12 | 0.76 | 0.052 | 1.09 | 0.42 | Increased spread of spongy patch. |

### Porosity.—Test III.

An entire departure from experimental shapes was attempted in this set of experiments. Automobile head castings of a design notorious for the development of porosity were made in irons having the same composition except for an increasing phosphorus content. Fig. 3 shows a section of the casting. The resulting castings were machined top and bottom and the bosses drilled in the usual way. Water pressure was applied to the inside jacket of the casting, and any leakage through the bosses was easily discerned. All castings reported as leaking were sawn up into sections across the leaking parts, and examined, with the results shown in Table IV.

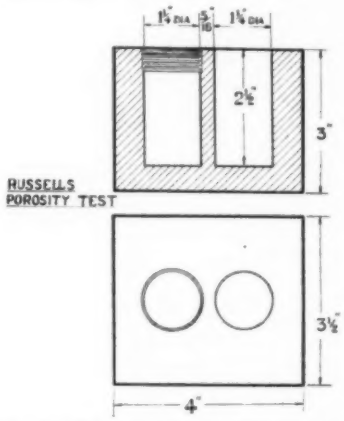



FIG. 2.—POROSITY TEST SUGGESTED BY MR. P. A. RUSSELL.

TABLE II.—*Blocks Without Feeder Heads.*

| Analysis. | | | | | | Pressure test results. |
|---|---|---|---|---|---|---|
| T.C. | Si. | Mn. | S. | P. | Cr. | |
| 3.30 | 1.80 | 0.80 | 0.050 | 0.080 | 0.30 | O.K. at 500 lbs. pressure. |
| 3.27 | 1.92 | 0.80 | 0.050 | 0.180 | 0.27 | O.K. at 510 lbs. |
| 3.30 | 1.94 | 0.84 | 0.052 | 0.320 | 0.31 | O.K. at 500 lbs. |
| 3.27 | 1.90 | 0.80 | 0.054 | 0.450 | 0.33 | O.K. at 500 lbs. |
| 3.30 | 1.95 | 0.85 | 0.050 | 0.440 | 0.29 | O.K. at 500 lbs. |
| 3.33 | 2.00 | 0.86 | 0.052 | 0.530 | 0.26 | Leaking without pressure. |
| 3.28 | 2.00 | 0.84 | 0.059 | 0.660 | 0.30 | Leaking without pressure. |
| 3.30 | 2.00 | 0.90 | 0.056 | 0.840 | 0.28 | Leaking without pressure. |
| 3.30 | 2.00 | 0.90 | 0.050 | 0.850 | 0.27 | Leaking without pressure. |
| 3.27 | 2.10 | 0.92 | 0.055 | 0.970 | 0.29 | Leaking without pressure. |
| 3.27 | 2.00 | 0.90 | 0.052 | 1.180 | 0.35 | O.K. at 500 lbs. |
| 3.30 | 2.10 | 0.94 | 0.056 | 1.170 | 0.40 | Leaking without pressure. |
| 3.30 | 2.00 | 0.92 | 0.050 | 1.520 | 0.36 | Leaking without pressure. |

### Phosphorus and Keep's Contraction Test.

The usual procedure was followed as laid out for this test, namely, the casting of two bars, 24 in. by 1 in. by 1 in., run from one end and cast flat in an iron frame, which has its inside faces accurately machined. The contraction being measured by means of a wedge pushed between the bars and the end of the frame. A

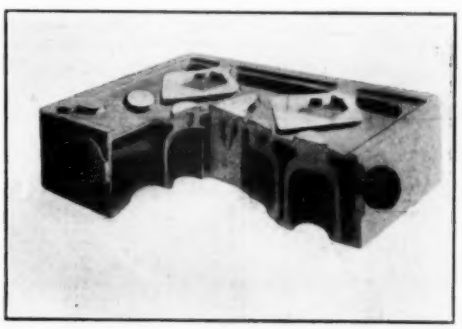


FIG. 3.—CASTING USED AS POROSITY TEST.

pop mark was made on the wedge at the point of contact. The wedge then withdrawn from the frame and its thickness on the pop mark measured by a micrometer. The results are shown in Table IX.

Table III.—*Blocks with Feeding Heads.*

| Analysis. | | | | | | Pressure test results. |
|---|---|---|---|---|---|---|
| T.C. | Si. | Mn. | S. | P. | Cr. | |
| 3.40 | 2.16 | 0.89 | 0.042 | 0.56 | 0.25 | O.K. at 500 lbs. |
| 3.41 | 2.10 | 0.90 | 0.045 | 0.66 | 0.25 | Leaking without pressure. |
| 3.39 | 2.12 | 0.92 | 0.046 | 0.79 | 0.23 | O.K. at 500 lbs. |
| 3.27 | 2.10 | 0.90 | 0.042 | 0.76 | 0.30 | O.K. at 500 lbs. |
| 3.25 | 2.10 | 0.90 | 0.045 | 0.92 | 0.30 | O.K. at 500 lbs. |
| 3.27 | 2.10 | 0.89 | 0.050 | 1.01 | 0.30 | O.K. at 500 lbs. |
| 3.37 | 2.10 | 0.90 | 0.037 | 1.19 | 0.38 | Leaking without pressure. |

**Phosphorus and Chill Test from Keep's Test.**

One and a-half inches was sawn from the chilled end of each bar and a ½-in. hole drilled as far as possible in the direction of the chill from the soft end. The pieces were then split by means of a steel wedge and the chill measured.

Table IV.—*Automobile Head Casting with increasing Phosphorus Content.*

| Analysis. | | | | | | Pressure test results. |
|---|---|---|---|---|---|---|
| T.C. | Si. | Mn. | S. | P. | Cr. | |
| 3.30 | 1.90 | 0.80 | 0.060 | 0.045 | 0.31 | O.K. on water test. |
| 3.36 | 1.90 | 0.81 | 0.062 | 0.110 | 0.27 | O.K. on water test. |
| 3.37 | 1.90 | 0.80 | 0.058 | 0.110 | 0.33 | O.K. on water test. |
| 3.30 | 1.90 | 0.80 | 0.050 | 0.260 | 0.30 | Leaking, spongy in bosses. |
| 3.36 | 1.90 | 0.79 | 0.048 | 0.300 | 0.32 | Leaking, spongy in bosses. |
| 3.33 | 1.94 | 0.81 | 0.058 | 0.410 | 0.27 | Leaking, spongy in bosses. |
| 3.30 | 1.92 | 0.82 | 0.058 | 0.490 | 0.30 | Leaking, spongy in bosses. |
| 3.27 | 2.00 | 0.80 | 0.060 | 0.650 | 0.34 | Leaking, spongy in bosses. |
| 3.33 | 2.00 | 0.78 | 0.060 | 0.790 | 0.25 | Leaking, spongy in bosses. |
| 3.39 | 2.00 | 0.75 | 0.058 | 0.860 | 0.25 | Leaking, spongy in bosses. |

Table V.—*Mechanical Test Results on Bar S—Cast with* 0.875 *in. dia. and machined to* 0.564*in. dia.*

| Test No. | Analysis. | | | | | | M.S. Tons per sq. in. | Brinell No. (cast bar). |
|---|---|---|---|---|---|---|---|---|
| | T.C. | Si. | Mn. | S. | P. | Cr. | | |
| 1 | 3.27 | 2.00 | 0.89 | 0.040 | 0.07 | 0.28 | 18.9 | 229 |
| 2 | 3.33 | 2.08 | 0.87 | 0.050 | 0.26 | 0.36 | 18.2 | 228 |
| 3 | 3.27 | 2.10 | 0.93 | 0.036 | 0.29 | 0.32 | 19.1 | 248 |
| 4 | 3.33 | 2.10 | 0.85 | 0.048 | 0.46 | 0.38 | 19.1 | 248 |
| 5 | 3.30 | 2.10 | 0.86 | 0.055 | 0.49 | 0.40 | 17.5 | 248 |
| 6 | 3.30 | 2.10 | 0.81 | 0.055 | 0.58 | 0.30 | 17.5 | 245 |
| 7 | 3.27 | 2.14 | 0.92 | 0.044 | 0.66 | 0.28 | 16.3 | 241 |
| 8 | 3.30 | 2.10 | 0.77 | 0.060 | 0.69 | 0.31 | 16.7 | 225 |
| 9 | 3.27 | 2.12 | 0.91 | 0.044 | 0.76 | 0.27 | 14.4 | 229 |
| 10 | 3.27 | 2.14 | 0.78 | 0.052 | 1.01 | 0.30 | 14.8 | 235 |
| 11 | 3.30 | 2.08 | 0.89 | 0.052 | 1.07 | 0.35 | 14.8 | 255 |
| 12 | 3.27 | 2.20 | 0.92 | 0.048 | 1.13 | 0.27 | 12.3 | 269 |

**Phosphorus and Porosity.**

The outstanding feature of all the experiments detailed in this Paper is the effect of phosphorus on the soundness of a cast-iron section. The three sets of porosity experiments cover the junction of sections in a medium size of casting, a heavy solid block, and commercial type of castings, which necessitate the use of internal cores, and must withstand water pressure. Under 0.3 per cent. phosphorus provides a sound range of compositions in each set of experiments, and these may be taken without much question as representing three differing types of sections and designs. The range of total carbon and silicon contents rather lend confirmation to the results, for had either of these factors been present in a lesser amount than stated, this fact could only have caused the sections to have had a closer grain and drawn to a lesser degree. Further experimenting could be carried out in a similar manner with series of lower total carbon and silicon contents, and the results would provide a wider range of information.

Table VI.—*Mechanical Test Results on Bar M—Cast* 1.20 *in. dia., and Machined to* 0.798 *in. dia.*

| Analysis Test No. | M.S. Tons per sq. in. | Brinell No. |
|---|---|---|
| 1 | 15.2 | 215 |
| 2 | 14.5 | 219 |
| 3 | 16.4 | 223 |
| 4 | 14.6 | 229 |
| 5 | 14.0 | 241 |
| 6 | 14.0 | 241 |
| 7 | 11.9 | 235 |
| 8 | 12.9 | 241 |
| 9 | 13.9 | 212 |
| 10 | 11.5 | 217 |
| 11 | 13.3 | 223 |
| 12 | 12.3 | 262 |

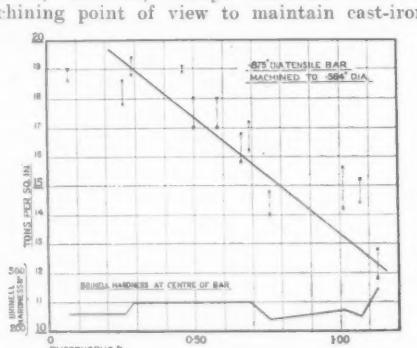



Fig. 4.—Influence of Phosphorus on the Tensile and Brinell Hardness (Table V).

It is, however, always desirable from a machining point of view to maintain cast-iron castings with the maximum degree of softness in these days of production, providing always that such softness is commensurate with the measure of strength and solidity in the section as required. A further factor which has now been proved as a result of these experiments is, that to consider a carbon-silicon balance only to effect soundness in cast-iron sections is totally inadequate to enable a correct control and results to be obtained. Where sections in a casting materially differ in dimensions, it is the most difficult task, that a foundryman can be set, to control these two elements without having hardness in the thin sections on the one hand or porosity in the thick sections on the other.

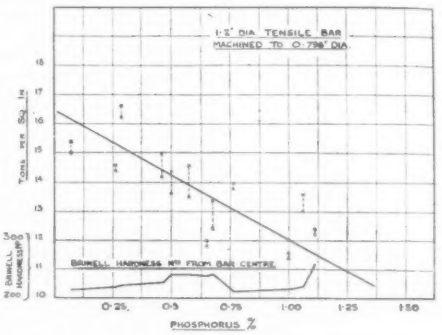



Fig. 5.—Influence of Phosphorus on the Tensile Strength and Brinell Hardness (Table VI).

Fig. 4 is a typical curve of total carbon-silicon control, covering a period of one week, when melting cast iron in a cupola for such castings with a diversity of sections. The analysis of the mixture aimed at was total carbon 3.2 per cent., silicon 1.40 per cent.—a greater limit than 0.1 per cent. silicon or 0.2 per cent. total carbon. Variation would cause one of two extremes, *i.e.*, hardness or porosity to be experienced during machining. The phosphorus content by design was maintained at 0.6 to 0.7 per cent. The effect of reducing the phosphorus content of the mixture to under 0.3 per cent. has had the remarkable effect of allowing with the same total carbon content a wide variation of silicon to the extent of 0.5 per cent. without the

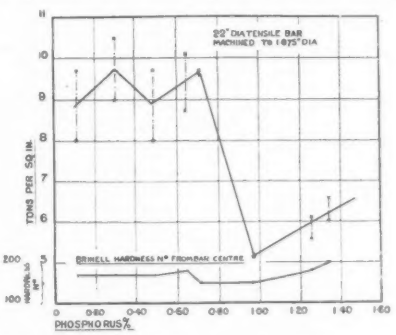



Fig. 6.—Mechanical Test Results on Bar L (Table VII).

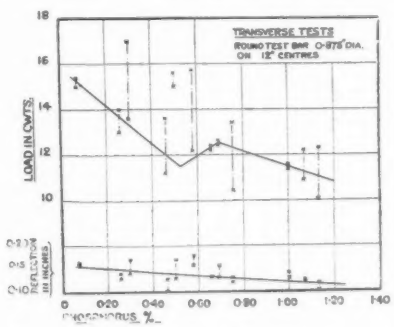



Fig. 7.—Influence of Phosphorus on Transverse Strength at 12 in. Centres (Table VIII).

occurrence of either hardness or porosity should the extremes be touched. This phase of phosphorus interference is of utmost importance to all foundrymen, especially for those who are depending upon an outside source for their supply of scrap cast iron, and also for those who must produce castings to withstand pressure of any kind.

TABLE VII.—*Mechanical Test Results on Bar L—Cast 2.20 in. dia. and Machined to 1.785 in. dia.*

| Test No. | Analysis. | | | | | | M.S. Tons per sq. in. | Brinell No. (cast bar). |
|---|---|---|---|---|---|---|---|---|
| | T.C. | Si. | Mn. | S. | P. | Cr. | | |
| 13 | 3.37 | 1.92 | 0.81 | 0.056 | 0.085 | 0.27 | 9.8 | 170 |
| 14 | 3.37 | 1.94 | 0.80 | 0.056 | 0.350 | 0.27 | 9.8 | 170 |
| 15 | 3.36 | 2.00 | 0.82 | 0.058 | 0.470 | 0.25 | 8.9 | 170 |
| 16 | 3.36 | 2.00 | 0.78 | 0.056 | 0.560 | 0.25 | 9.9 | 179 |
| 17 | 3.27 | 2.00 | 0.80 | 0.056 | 0.720 | 0.25 | 9.7 | 149 |
| 18 | 3.40 | 2.02 | 0.82 | 0.060 | 0.930 | 0.27 | 5.1 | 149 |
| 19 | 3.40 | 2.00 | 0.76 | 0.060 | 1.200 | 0.27 | 5.7 | 179 |

In Tables V, VI, VII, the Brinell Numbers were taken at the centre of the cast bar, and are the average of two tests, as are also the tensile results.

### Phosphorus and Tensile Strength.

The results shown in each series are from duplicate bars, and in some cases the variations between them and in comparison with their neighbours are not easily explained. The results plotted as graphs, however, give a general idea, and it is interesting and rather remarkable that with each size of bar there is an increase in the tensile strength as the phosphorus rises to 0.3 per cent. This coincides with the work of Wüst and Mackenzie, who found that the maximum strength of a series of cast-iron test-pieces was reached with a phosphorus content of 0.3 per cent., after which there occurred a gradual decrease in this value. With the 2.2-in. bars, however, the higher strength would appear to be maintained up to a phosphorus content of 0.70 per cent.; this occurrence may be due to the selective segregation of the phosphide to the centre of the test-pieces, as in contrast to a more even distribution in the smaller size of bars.

TABLE VIII.—*Transverse Strength of Standard Bars with Increasing Phosphorus Content.*

| Test No. | Bar S. | | Bar M. | | Bar L. | |
|---|---|---|---|---|---|---|
| | Load in cwts. | Deflection in inches. | Load in cwts. | Deflection in inches. | Load in cwts. | Deflection. in inches. |
| 1 | 15.3 | 0.162 | 25.2 | 0.250 | 138.1 | 0.255 |
| 2 | 13.7 | 0.135 | 24.0 | 0.225 | 128.5 | 0.245 |
| 3 | 14.8 | 0.158 | 24.5 | 0.240 | 133.6 | 0.245 |
| 4 | 12.2 | 0.122 | 24.0 | 0.200 | 119.0 | 0.227 |
| 5 | 15.3 | 0.157 | 23.8 | 0.205 | 127.0 | 0.202 |
| 6 | 13.5 | 0.173 | 24.0 | 0.200 | 124.0 | 0.200 |
| 7 | 12.3 | 0.133 | 22.0 | 0.154 | 131.0 | 0.203 |
| 8 | 12.6 | 0.142 | 24.0 | 0.188 | 109.6 | 0.210 |
| 9 | 12.0 | 0.122 | 28.0 | 0.172 | 110.0 | 0.177 |
| 10 | 11.5 | 0.137 | 18.5 | 0.170 | 90.5 | 0.191 |
| 11 | 11.5 | 0.122 | 33.4 | 0.215 | 144.0 | 0.172 |
| 12 | 11.0 | 0.112 | 33.0 | 0.145 | 104.0 | 0.169 |

Bar S series listed at 12 in. centres and Bars M and L at 18-in. centres. Corrections have been made to conform to standard dimensions.

### Phosphorus and Hardness.

Brinell hardness tests were taken with a 10 m.m. ball and 3,000 kg. pressure on the centre of the section with each test-piece of the series. The results are plotted below the tensile strengths of each respective series. In the smaller sizes of bars there occurs a definite rise in hardness number as the phosphorus increases, but this is not shown so in the 2.2-in. bar series, in fact there occurs a slight drop as the phosphorus content increases. This phenomenon may arise from the presence of a certain degree of openness of fracture, or porosity which would occur at the centre of the bar in this, the thickest section of bars.

TABLE IX.—*Influence of Phosphorus on Contraction.*

| Test No. | Analysis. | | | | | | |
|---|---|---|---|---|---|---|---|
| | T.C. | Si. | Mn. | S. | P. | Cr. | Contraction. |
| 20 | 3.37 | 1.92 | 0.81 | 0.056 | 0.085 | 0.27 | 0.331 |
| 21 | 3.37 | 1.94 | 0.80 | 0.056 | 0.350 | 0.27 | 0.309 |
| 22 | 3.27 | 2.00 | 0.80 | 0.056 | 0.720 | 0.25 | 0.315 |
| 23 | 3.40 | 2.02 | 0.82 | 0.060 | 0.930 | 0.27 | 0.307 |
| 24 | 3.40 | 2.00 | 0.76 | 0.060 | 1.200 | 0.27 | 0.297 |
| 25 | 3.33 | 2.00 | 0.78 | 0.060 | 1.430 | 0.24 | 0.29 |

TABLE X.—*Chill Depth in Inches.*

| Test No. | Chill Depth in inches. |
|---|---|
| 20 | $\frac{7}{16}$ |
| 21 | $\frac{1}{2}$ |
| 22 | $\frac{1}{4}$ |
| 23 | $\frac{3}{16}$ |
| 24 | $\frac{3}{16}$ |
| 25 | $\frac{3}{16}$ |

### Phosphorus and Transverse Strength.

The results from these tests are not so distinct in their evidence as the tensile results, but in the smallest size of bar there occurs a definite drop in the transverse strength until the phosphorus content reaches 0.50 per cent., when an increase persists until an 0.70 per cent. is attained when a decrease continues until the end of the series. Within the heaviest bar series, that is, the 2.2 in. dia., a consistent drop in strength proceeds throughout the series. The results obtained from the 1.20-in. dia. series are interesting from the point of view that the decrease in strength is much less marked, with the lower increase of phosphorus contents, but at 0.30 per cent. this decline is arrested, and continues to 0.75 per cent. when the results become directly contrary. There is more evidence towards an upward trend of the tail than otherwise, but the confliction of the results for further confirmation.

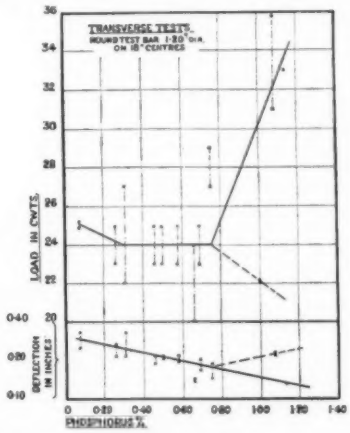



FIG. 8.—INFLUENCE OF PHOSPHORUS ON TRANSVERSE STRENGTH AT 18 IN. CENTRES (TABLE VIII).

### Phosphorus and Deflection.

The brittleness imparted to cast iron by the presence of increasing amounts of phosphorus is confirmed by the fall in deflection. There is nothing unusual shown by the results except for the conflicting results which occur and coincide with the contradictory figures given by the transverse test-pieces. Here again further experiments need to be carried out before any decision can be arrived at.

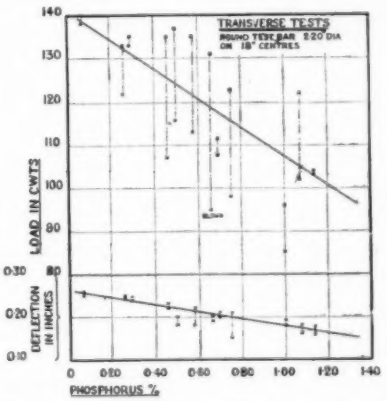



FIG. 9.—INFLUENCE OF PHOSPHORUS ON TRANSVERSE STRENGTH (TABLE VIII).

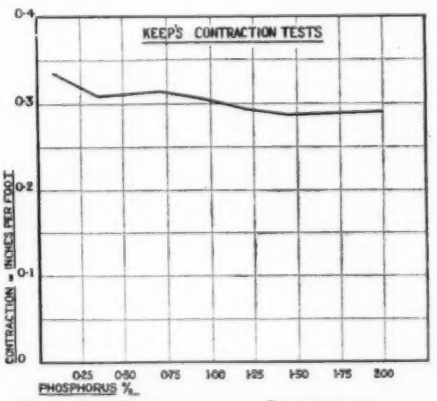



FIG. 10.—INFLUENCE OF PHOSPHORUS ON CONTRACTION (TABLE IX).

(*Concluded on page* 114.)

# Aluminium Bronze.

By Frank Hudson.

(*Continued from page* 89.)

### Foundry Practice.

It is surprising how many people think that aluminium bronze is a difficult alloy to handle in the foundry. Whilst admittedly it cannot be handled so easy, as say yellow brass, yet personal opinion is that the author would much sooner handle aluminium bronze as phosphor bronze. To obtain success it is important to recognise the following properties:—(*a*) High solidification shrinkage of about twice that of brass. Solid contraction according to the pattern-maker's scale is from $\frac{7}{32}$ to $\frac{1}{4}$ in. per ft., but solidification shrinkage is altogether of a higher order, and is emphasised by the extremely small range of temperature over which solidification takes place. In this respect, aluminium bronze is similar to steel, and the troubles of the brass-founder who fails to appreciate this factor would be on similar lines to the grey-iron man who attempts the production of steel castings without a knowledge of steel technique; (*b*) ease of formation of aluminium oxide by improper furnace practice or by agitation; and (*c*) strong tendency for absorption of gases during melting and consequent liberation in the solidification range.

In the Glenfield brass foundry there are three rules, namely:—(1) Only pure metals must be used for basis of charges. Impurities affect the resultant qualities enormously, and any scrap additions must be carefully considered prior to addition; (2) melting must be rapid and deoxidation controlled by manganese additions at every danger point. It is suggested that the Morgan tilting furnace be used rather than pit fires.

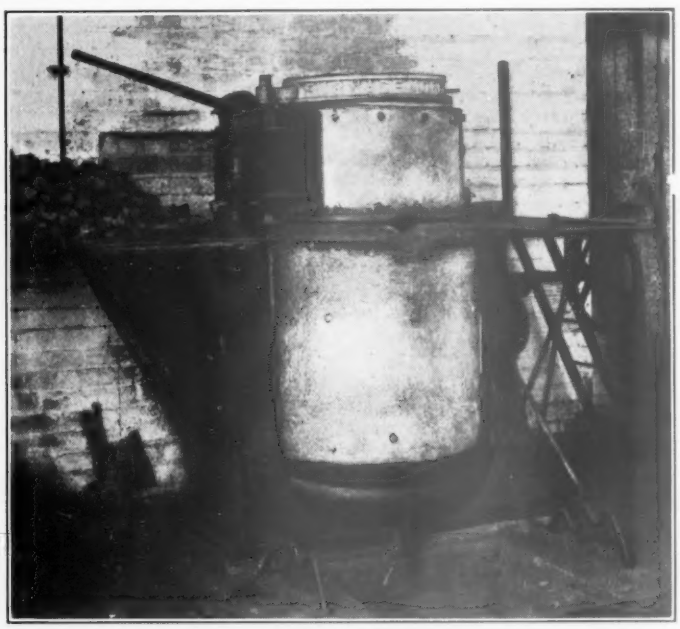


Fig. 16.—Suitable Type of Furnace for making Aluminium Bronze of 400 lbs. Capacity.

Stock alloys, such as aluminium copper, must be effectively deoxidised; and (3) ingots and moulds must be bottom poured and turbulence prevented at all costs. Ingot surfaces must be smooth, and if this is not obtained, then the surface should be machined prior to forging.

For general practice the author prefers to use either a coke- or oil-fired Morgan tilting furnace, such as is shown in Fig. 16, and the melting time, say for a 400-lb. charge, should not exceed 1 to 1½ hrs. In charging the furnace a small piece of manganese copper is first put into the bottom of the pot and best-selected copper and aluminium-bronze scrap from previous heats added. This is melted as quickly as possible under a good layer of heavy charcoal. If iron or nickel is required in the final composition, this is also added at the beginning, the iron being added as ferro-copper. When the charge is melted, it is again deoxidised by manganese-copper additions. The aluminium content is now made up to the required degree by additions of

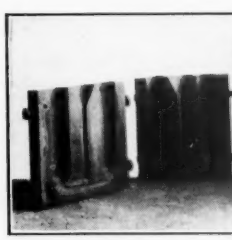


Fig. 18.—Bottom-Poured Cast-Iron Chilled Moulds.

Fig. 20.—First Type of Ingot Produced was Unsatisfactory.

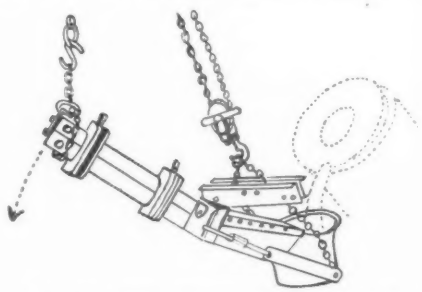


Fig. 17.—The Durville Method for Assuring Quiet Pouring Conditions.

50 per cent. aluminium copper, containing at least 0.2 per cent. manganese. The author strongly favours the use of manganese as a deoxidant, and considers that 0.5 to 1.0 per cent.

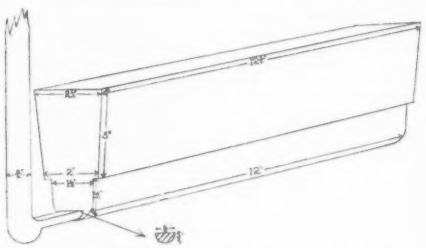


Fig. 19.—Method Used for Sand-Casting Test-Bars.

should be present in the final alloy. Finishings, such as aluminium copper, etc., are all made carefully under laboratory control. The raw materials used must not contain either arsenic, antimony, silicon or phosphorus. Furthermore, it is not considered good practice to add pure aluminium direct to the alloy. The aim should

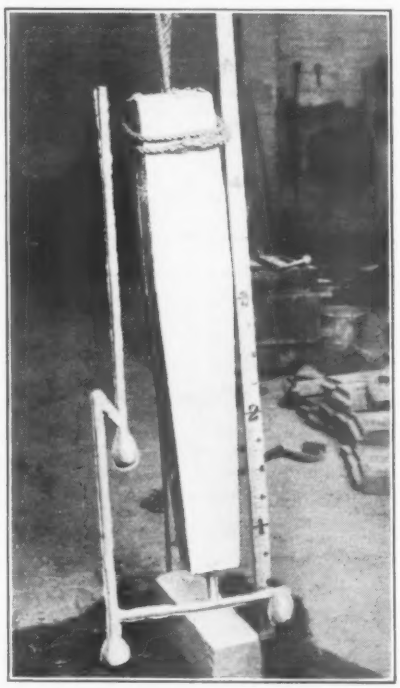


Fig. 21.—The Second Form of Ingot was Successful.

be to prevent the formation of aluminium oxide in the melt rather than to attempt its removal by deoxidation or use of fluxes such as manganese sulphate. After melting, the alloy is thoroughly skimmed and cast under pyrometric control at the lowest possible temperature commensurate with satisfactory filling of the mould. This aids in reducing shrinkage. It will be appreciated that it is not feasible to state any one definite casting temperature that should be used to obtain the best results, as this will vary according to the job being cast. For medium and light work, suggested limits would be between 1,150 and 1,200 deg. C., whilst for heavier jobs a lower range between 1,100 and 1,150 deg. C. could be used. To quote a particular example,

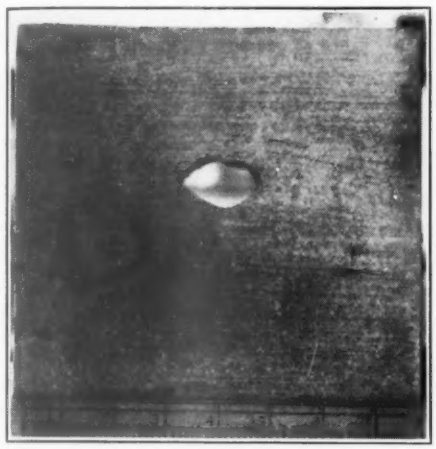


FIG. 22.—THE HEADS CUT FROM THE INGOTS SHOWN IN FIGS. 20 AND 21.

it is our practice to pour chill-cast ingots varying from 3 to 8 in. in section between 1,140 and 1,160 deg. C. In casting, it is highly important to ensure that the entry of the metal into the mould be very quiet, free from ripples, surges, splashing and jet effects. If this is not ensured, aluminium oxide will be formed to the entire detriment of the casting and subsequent forging or machining operations.

As well as ensuring the quiet entry of the metal into the mould, it is of like importance to ensure that the metal lies quietly inside the mould, and consequently care should be taken in having the mould, if made of sand, of such a nature as to cause minimum disturbance. The successful production of high-quality alloys of the aluminium-bronze group very definitely depends on the prevention of oxide formation. Aluminium oxide, or alumina, has an approximate melting point of 2,050 deg. C., and once formed is very difficult to remove. In France considerable quantities of aluminium bronze are made into ingots by the "still-casting process." Fig. 17 illustrates the method ascribed to Durville. In this method the ladle is rigidly attached to the chill mould and pouring accomplished with minimum disturbance by tilting the whole system on a vertical plane. Quite excellent ingots can, however, be made in simple bottom-poured cast-iron chill moulds, as shown in Fig. 18. This type is used for the bulk of work described in this Paper. The chilled faces are machined, and smooth ingots can be obtained which do not, as a rule, require machining prior to forging. Depreciation of the mould surface is rapid and they should be re-faced when necessary.

In regard to chill moulds, it will no doubt be of interest to mention in passing the growing favour of water cooling. Water-cooled ingot moulds not only effect a more rapid transfer of heat, but they also suffer less depreciation and have proved a most economic proposition in many works. Probably the most serviceable mould of

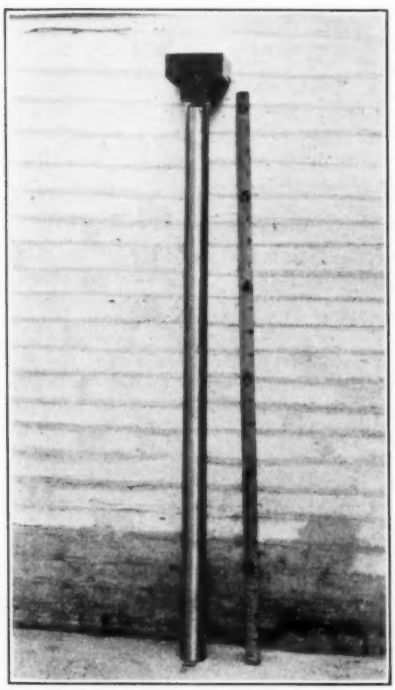


FIG. 23.—THE FINISHED SPINDLE.

this type is that developed by Junker. In isolated cases where ingots of special size are required, recourse can be made to the use of a chill-faced sand mould, as will be outlined later.

Fig. 19 illustrates the method used for producing sand-cast test-bars. Subsequent test results, representative of the sand-cast alloys, have been made from this form of bar, and in practice the results obtained have been superior to those obtained by other methods. The top 2½-in. by 3-in. section is feeding head.

### Forging Practice.

All of the aluminium bronzes from 5 per cent. of aluminium upwards are readily forged, rolled and otherwise worked. Speaking generally, the higher the aluminium content the easier is forging conducted. Alloys between 5.0 and 8.5 per cent. aluminium are particularly susceptible to forging methods and very excellent test figures can be obtained by forging at temperatures between 730 to 800 deg. C. Normally forging commences at around 900 deg. C. Care must be taken to prevent the occurrence of internal shear, caused by too free a flow, and bars are preferably formed by swaging. Beyond these brief remarks there is no need to go further, as any serious defects arising can usually be attributed to the presence of casting defects such as oxide segregation. Pyrometric control of reheating furnaces is, however, very desirable.

The next few Figures illustrate pictorially the manufacture of a large forged-aluminium bronze sliding spindle as used in valve construction, and indicate the wrong and the right way of manufacture. Moreover, at the end there is a metallurgical problem of considerable interest. In the first instance, the job was a special one and no ingot mould was available. Furthermore, the foreman smith had not suitable tackle for handling any shape of ingot. Finally, the spindle was urgently required. The natural sequence of these facts led to the production of the ingot as shown in Fig. 20. This was cast in dry sand, stripped at a red heat and quenched by a water spray to prevent "Self-annealing." The top section of the ingot was 8 in. square by 18 in. long, and of this 10 in. was head. When the head was removed a "pipe" was disclosed extending the full depth of the square section. This was not unexpected. A replace ingot was cast to the form shown in Fig. 21. The mould in this case was lined with 1½-in. thick cast-iron plates corresponding to the ingot required, whilst

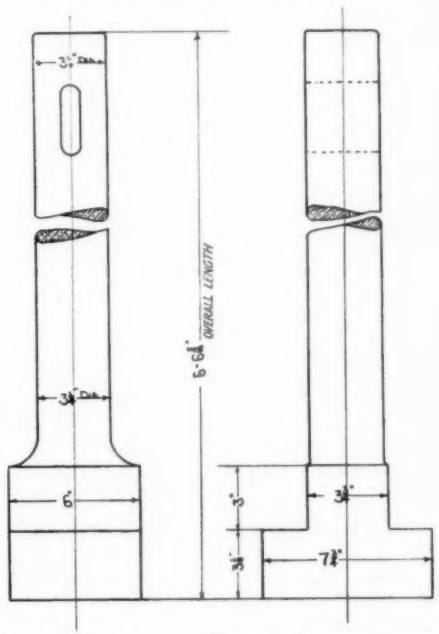



FIG. 24.—ALUMINIUM BRONZE SLIDING SPINDLE FOR 54 IN. DIA. SLUICE VALVE. FINISHED WEIGHT: 1 CWT. 3 QRS. 18 LBS.

*Analysis.* – Copper, 84.78 per cent.; aluminium, 9.83 per cent.; iron, 4.59 per cent.; manganese, 0.80 per cent.

*Physical Properties after Forging Base of Ingot.*— Yield point, 16.8 tons sq. in.; max. stress, 38.4 tons sq. in.; elong. on 2 in. = 12.0 per cent.

an extension of the mould, not chilled, provided the requisite feeding head. The junction of sand and chill portions is clearly shown in the illustration. The job was cast at 1,140 deg. C. Attention should be drawn to the runner entering the ingot base which had to pass through the 1½-in. chill plates and consequently was partly chill cast and partly sand cast. This section provides the metallurgical problem of considerable interest referred to a few minutes ago. Before examining this runner section, however, it should be pointed out that the second ingot was perfectly sound. Fig. 22 illustrates the removed head portions, whilst Fig. 23 shows the finished spindle. Fig. 24 gives final analyses and test results obtained.

*(To be continued.)*

---

SIR W. H. PEAT has been appointed trustee for the debenture-holders of the Crittall Manufacturing Company, Limited, in place of the late Sir C. J. Stewart.

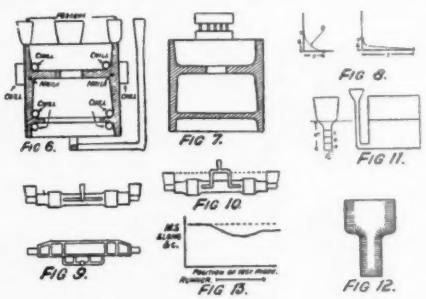
# Notes on Some Common Defects in Steel Castings.

By C. Howell Kain.

(*Concluded from page 96.*)

### Inadequate Feeding.

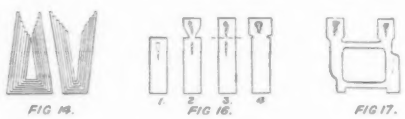
Under the second heading it is often hard to decide whether the defect is really a shrink or a crack, but as the fault usually has the appearance of a ragged crack on a machined surface it is decided to class it as a crack. Fig. 6 shows a very good example. The casting is a wheel with two internal flanges forming a heavy section at the join with the body. When the castings were machined a series of fine ragged cracks was exposed on both the internal and external faces. The castings had a bottom runner to ensure cleanliness, and headers, chills and nails were all used in an effort to make them sound. Fig. 6 shows all these methods carried to extremes, but this failed to produce sound castings. The casting could, of course, have been made on the side and fed by headers over the flanges, but this would have increased the moulding cost owing to the difficulty of balancing the heavy internal cores. Fig. 7 shows how the trouble was overcome. A small header was used with five $\frac{3}{8}$-in. dia. pencil gates. This method of casting enabled the mould to be filled so slowly as to allow progressive solidification as the metal rose in the mould. The




troublesome sections thus automatically fed themselves sound. Incidentally, this method required only 24 lbs. of metal in the head and runner while the original method used 45 to 50 lbs.

This type of crack often appears round the base of heavy bosses on light sections, and in this case a heavy internal chill made of the same material as the metal is often very efficient. But the only really satisfactory cure is efficient feeding. This may be helped by careful design of the fillets in the corners. On the left in Fig. 8 is shown the usual design, and on the right a design which is much more efficient. A little thought is necessary in using this, and the direction of the long leg must be varied according to the design of the casting, the distance from feeders, and the position of the runner. But, correctly applied, this fillet often saves endless troubles with chills, cracking webs, etc.

Fig. 9 shows a casting which, quite unexpectedly, gave considerable trouble with cracks. The castings of this type vary from 6 to 15 ft. long, and consist of a simple H-section, with cored lightening-holes and a heavy trunnion at each end. Provided that the necessary headers at each end are adequately released and freed, one would expect these castings to contract normally and safely, the centre portion cooling first and drawing the ends inwards. Unfortunately, a large proportion cracked, in spite of gating, by three different methods: from one end, from both ends and along the side. With the first, the cracks are probably due to differential cooling, caused by heating of the mould at the runner end. In the second method, the junction of the coolest metal in the centre is the cause, and in the third the crack appeared to be caused by the presence of a large heavy runner channel alongside the casting, acting as an extra member. The difficulty was overcome by the method shown in Fig. 10. Two side runners were used, with two down-gates, the down-gates being filled from a bush on the level of the riser heads. Immediately pouring ceases, the whole bush and runner is pulled away at the level X—X. This, of course, makes rather a splash, but the cracks have quite disappeared. Cracks of this kind are often very disconcerting, and do




not yield to treatment by the usual methods of soft ramming, easing, chills, webs, etc. Only a careful study of the cooling conditions can indicate the solution.

### Classification of Cracks.

In classifying cracks as being caused by weakness of metal section it is meant to imply that the cracks are caused by the weakness of the metal itself, and not by weakness of design. A few years ago a Symposium on Steel Castings was held in Glasgow, and in one of the Papers it was shown that even if all the sections of a casting are perfectly uniform it does not follow that all parts have the same strength. After

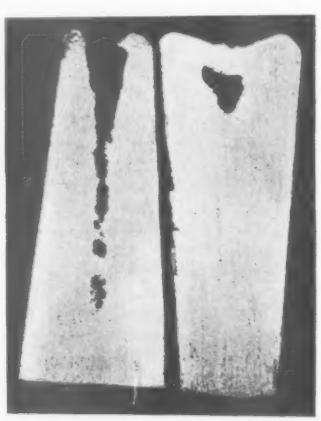


FIG. 15.—ONE OF BREARLEY'S EXPERIMENTS IN INGOT SHAPE.

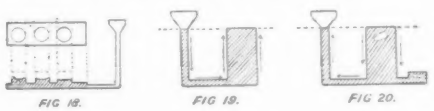
reading that Paper the present writer tested a number of standard shop-test blocks to ascertain the variation in the different bars. Fig. 11 shows the shape and dimensions of this block. The tongue is large enough to allow three $1\frac{1}{8}$ in. sq. bars to be cut, one for the tensile test, one for the bend test and one for a standby in case of failure with either of the others, or in case of hidden flaws being discovered. In the experiments all three bars were turned to the standard B.E.S.A. dimensions for tensile test-pieces, and pulled. They are marked "A," "B" and "C" from the bottom up. Table I is a fair illustration of the results obtained. Many bars were tested, and the same variation was found in them all. Bar "A" gives the best result, bar "C" the next best and bar "B" the worst. The difference is shown most by the elongation, the other properties being fairly uniform. Similar results were obtained by cutting three bend-test-bars from the block.

In Fig. 12 an attempt has been made to show the position diagrammatically just before the final freezing of the block. As the metal cools, it freezes in a continually thickening envelope on all sides. The first crystals or dendrites formed conduct the heat away from the liquid in the centre, which then solidifies and carries the process a little further into the remaining liquid. A point is very quickly reached when there is a very thin column of liquid metal in the centre, and the heat is conducted away from this so rapidly that crystallisation starts almost

TABLE I.—*Tests.*

| Position. | Yield pt. | M.S. | E. per cent. |
|---|---|---|---|
| A | 20.48 | 31.80 | 34 |
| B | 21.06 | 31.48 | 24 |
| C | 20.28 | 31.18 | 28 |
| A | 20.28 | 33.64 | 31 |
| B | 19.72 | 33.52 | 22 |
| C | 19.40 | 33.04 | 26 |

simultaneously down the full depth, from centres independent of the original dendritic walls. As these last crystals form, they contract, and rely on the liquid falling by gravity from the head to feed the minute spaces left, but the pressure and fluidity of the metal left in the head is only sufficient to force its way a short distance down. It will be seen, then, that since Bar "A" freezes from three sides, it consists entirely of primary crystals, while the centres of Bars "B" and "C" consist of secondary crystals. The feed metal from the head has fed Bar "C" efficiently, but not Bar "B," and although Bar "B" appears to be perfectly solid, it seems logical to conclude that there are tiny microscopical spaces between the crystals. The obvious thing would appear to be the use of a block of two bars only, and many people do this, but although no difficulty is experienced in meeting the requirements of inspectors, it is best to have a third bar, since the block must be attached to the casting, and the metal often has a con-




siderable distance to run before entering the test block, and there is always the possibility of collecting dirt and so causing a flawed bar which will affect the test.

These results were published in a Paper* read to the London Branch in 1927, and since that date further experiments have been carried out. A test block 8 in. by 10 in. by $1\frac{1}{4}$ in. was cast vertically, horizontally and at various angles, some with headers and some without. Each block was then cut into 10 test-pieces and tested in tension in the as-cast state. The results are fairly voluminous, but Fig. 13 shows the form of the curve obtained by plotting the results against the position of the bar. Maximum stress, elongation and reduction of area all followed the general shape of this line very closely, having a maximum at the runner end, falling off considerably in the centre, and rising again at the farthest end.

From these figures it follows that it is not safe to assume that because a casting has uniform section it is free from danger. When the stresses and strains occur during freezing and cooling, a casting may easily crack through what appears to be one of its strongest parts, due to starvation of that part during cooling. The only really safe remedy is adequate feeding, and a header placed half-way along a perfectly plain uniform bar will often save endless trouble.

* FOUNDRY TRADE JOURNAL. November 17, 1927. page 125.

It is interesting to note that these results exactly agree with similar work carried out by the late Mr. H. C. Dews on bronze. Mr. Dews came to the same conclusions regarding the necessity of feeding even the most uniform sections. An effort has been made to attack the problem from a new angle, and it is hoped that the suggestions made may be of some use.

### Draws.

Owing to the high shrinkage and change of volume of steel on freezing, the problem of draws or shrinks is always a source of anxiety. Even in the ingot, which is the very simplest form of steel casting made, great difficulty is encountered in obtaining sound castings. Considerable research has been done by Roberts-Austen, Brearley, McCance and many other workers, in the effort to reduce the amount of feeder-head necessary to obtain soundness, and the principles laid down by these authorities for the production of sound ingots are applicable to sand castings if due allowance is made for the different conditions caused by the sand mould being used in place of a metal one, and for the more complicated shapes and variations of section.

Fig. 14 is taken from the work of Brearley, and shows how steel freezes in an ingot mould. The object of this illustration is to enable one to visualise the steel solidifying in a continuously-thickening envelope or layer from the outside to the centre. On the left it is seen that if the top is narrower than the bottom, an internal cavity is formed, which cannot be fed from above owing to the freezing of the narrow portion. On the right it is seen that the bottom freezes first, leaving a cavity which may be fed solid by liquid metal from a header above. In the case of ingots, the top is usually open to the atmosphere, and this cools the top layer of metal and forms a bridge. This effect may be overcome by the use of some heating agent, or an addition, which lowers the freezing point of the metal, such as charcoal or anthracite. But the general effect is the same, as shown in Fig. 15, which is an actual photograph of two steel ingots. The production of ingots is a very large subject, and many methods are in use to ensure the ingots being suited to their purpose. In some cases "wild" or "gassy" steel is deliberately poured to overcome the pipe; in others pressure is applied; and in the case of special steels, practically one-half of the ingot is scrapped in order to obtain the sound portion. But the simple examples shown demonstrate the principles necessary for the production of castings.

The facts to be borne in mind are these: that the metal decreases in volume by over 6 per cent., that the thin portions tend to freeze first and draw supplies of liquid metal from the heavier portions, and that ultimately the shrinkage must be made up from outside sources. The ideal sought is to have solidification proceeding from the bottom upwards in order that the casting may feed itself naturally by gravity. The shape of the casting often prevents this, and sometimes artificial means such as chills or horse-nails are used to compel a casting to solidify in the manner desired. In many castings the difficulty is complicated by the necessity of placing the runner in the thinner portions of the casting. The hot metal passing over the sand near the gate so heats the sand as to prevent the metal cooling quickly, and in some cases the thin portions may actually freeze last. This fact should be borne in mind whenever the position of a runner is being considered. In spite of these complications the principles of progressive solidification, with uniform cooling and the heads last to freeze, must be remembered.

In Fig. 16 an attempt has been made to show the development of the correct type of feeder-head on a perfectly plain parallel casting. No. 1 is cast with no header, and forms a cavity or pipe within the casting. No. 2 has a head with a narrow neck to facilitate removal; this forms a pipe in the head, and because the narrow neck freezes before the rest of the casting, a pipe is formed in the casting itself. No. 3 has a head carried up parallel and of the same size as the casting. A pipe is formed in the head, but there is a danger of a second pipe forming near the top of the casting; this may be a continuation of the pipe in the head or may be a secondary pipe formed by the freezing of the casting from the sides and bridging over before the whole of the metal in the casting is solid. No. 4 shows the correct header. This is of larger cross-section than the casting, and remains liquid while the casting is freezing. It has a large connection with the casting which does not freeze over.

Fig. 17 shows how this principle operates in practice. From the moulding viewpoint this casting is very simple, but it is obvious that whichever way one casts it there will be a heavy section to feed through a lighter portion. In a case like this the only alternatives are a modification in design, a heavy and expensive header carried down one side of the lighter sections, or the use of chills and nails in the bottom heavy portion.

Owing to the high melting point of steel and the short range of liquid temperatures available, it is usual to pour steel at a very fast rate. This sometimes causes difficulty, due to the carrying in of air-bubbles and the scouring of the sand. If one of these air bubbles or sand particles should lodge near the surface, the slower cooling of that portion of metal invariably causes a draw. Therefore every effort should be made to introduce the metal as quietly as possible.

A study of light-steel castings intended for the automobile industry has shown that the size of cavity formed in bosses, etc., is often out of all proportion to the size of the section. Even in castings where there has been no indication of "blowing" or violent disturbance during pouring cavities have been found as large as 15 to 20 per cent. of the volume of the section. The well-known work on the pre-solidification of certain non-ferrous alloys inspired the question as to whether this process could profitably be used for steel. The process is as follows:—Certain non-ferrous alloys which normally give trouble in casting, due to the formation of numerous blow-holes, are melted in the usual way. Once they are completely molten the source of heat is removed and the metal allowed to solidify quietly in the crucible or furnace. When the metal is solid (but, of course, still hot, being just below the melting point) it is quietly re-melted and poured. It has been found possible, by this method, very considerably to reduce the amount of blow-holes and cavities in the castings. A number of heats of steel have been treated in this way, but at the moment, it is not possible to give any definite figures on the results. In general, there appears to be a marked diminution in the size of the cavity in the bosses cast on a thin plate with no riser, but it is feared that the cost of the process makes it impracticable for ordinary production. The process is used to some extent on the Continent, but in this case the object is to obtain a dead-soft steel for electrical purposes.

### Blowholes.

Whenever a machinist or an engineer rejects a casting for a defect, it is invariably called a "blowhole," this being the only one of the numerous banes of the founder's existence which is commonly known. Blowholes are of many and diverse types, but they all spring from one of these three causes: (1) The metal, (2) the mould or (3) agitation during pouring. It is proposed to consider these causes in that order.

### Blowholes due to Faulty Metal.

As this Paper is not a metallurgical treatise, only the very briefest mention may be made of the making of the steel. Blow or gas holes originating from the metal arise either from chemical action in the steel or from the release of dissolved or occluded gases. Steel-making processes are now so thoroughly understood that wild or gassy steel is very rarely produced. When trouble does arise it is usually quickly traced to poor melting technique or careless oxidation of impurities. It is now known that the old methods of melting at the fastest possible rate, regardless of other conditions, and relying on deoxidising or finishing additions to produce sound steel, are wrong, and that care must be used both in the selection of the charge and in the conditions of melting. This applies to all steel-making processes.

An occasional cause of trouble is the presence of steam from insufficiently-dried ladles or shanks. All ladles and shanks should be thoroughly dried, and preferably raised to a red heat, before tapping the furnace.

### Blowholes due to Faulty Moulds.

The majority of blowholes undoubtedly arise from the mould or mould materials. These include not only the sand, but binders, facings, nails and chills. Nails and chills are usually fixed in position before a mould is dried in the stove. If the atmosphere of the stove is at all oxidising, the metal surfaces become oxidised and rusted. When the molten steel is poured round these rusted surfaces gas is generated by the action of the iron oxide on the carbon in the steel.

$$FeO + C \rightarrow Fe + CO$$
$$2FeO + C \rightarrow 2Fe + CO_2$$

Owing to the rapid cooling of the steel this gas cannot get away, and a blowhole is formed. In addition to the chemical generation of gas from the oxide, the rust is hygroscopic, and very rapidly absorbs moisture when the mould cools after drying, particularly if the mould is closed before being perfectly cool. It is unnecessary to mention the damage done by this water during casting. Even if the chills and nails are perfectly clean after drying, or if, because the mould is to be used in the green state, the chills are not subjected to oxidising conditions, moisture condenses on the metal very rapidly once the mould has been closed.

An attempt was made to obtain some actual photographs of this, but unfortunately they were so indistinct as to be useless. But it was found that in the case of a cold green-sand mould visible moisture appeared on the heads of horse-nails three hours after closing. In the case of dry-sand moulds closed while still warm condensation occurred almost at once, and in the case of dry-sand moulds allowed to get cold before closing, beads of water appeared after only a few hours. It is obvious, therefore, that if chills and nails must be used, the mould must be cast as soon as possible after closing. Dry-sand moulds are affected by similar factors, but as these are universally used it is thought that the facts must be too well known to need repetition here.

Much has been said of the dangers of excess water in green-sand moulds, but it is present experience that very much more latitude is allowable than is commonly supposed, provided that there are no local segregations or seepings. It is present practice to maintain the free water content of green sand at 3½ to 4 per cent., as this is found suitable for the work in hand. But if castings are required with deep and difficult draws and lifts it is better to increase the water content of the sand up to 5 or 5½ per cent. rather than to make free use of the swab brush and water pot. Excessive water used for making-up, patching or sleeking a mould causes far more blowholes than a few extra degrees of water in the prepared sand.

It is interesting to note that synthetic sands built up from pure silica sand and a natural fatty clay always appear much wetter for the same amount of water than sand built up from dried clays or binders, or naturally-bonded moulding sands. This fact accounts for many

failures with synthetic sands using dried fireclays or kaolins, as excessive water has to be added in order to obtain the "tacky" feel of the natural clayey sands. When using synthetic sands, it is essential carefully to control the amount of water added. One characteristic of sands made from dried clays is that they "air-dry" on the surface very rapidly when exposed to the atmosphere, leaving a dry crumbling surface which washes away before the flow, causing rough and dirty castings. It is better to aim at pouring these moulds as soon as possible rather than to try to keep the mould face intact by adding water. Natural fatty clays retain the mould face much longer than dried clays, but difficulty is always experienced in completely breaking down the nodules of clay. Unless the clay is perfectly broken down and distributed through the sand, the nodules of free clay left fuse and swell when the metal comes into contact with them, causing defects on the face of the casting, and, in many cases, blowholes. The author is unaware of a really satisfactory mill for the mixing of fatty clays and sand. Perfect mixing can be obtained by drying the clay, with the inherent difficulties of dried-clay sands, or by making a clay-slush, in which case the sand is far too wet to use, and must be air-dried for many days before use. Neither of these two methods is really satisfactory in the foundry. Of course, most of these difficulties disappear when using dry-sand moulds.

It is important that the sand used should be thoroughly milled and mixed, because the majority of the bonding materials and binders used have a lower-melting point than the sand. In addition, most of them contain a considerable quantity of chemically-combined water, which is driven off at the high temperatures attained. This, of course, does not apply to oil sands, but even with these, unless the core is carefully dried excessive volumes of gas are given off. If the sands are not properly mixed local nodules or segregations of the binding medium persist, and these readily fuse when the mould is poured, giving off volumes of gas and swelling sufficiently to fracture the mould face, causing scabs and dirty castings.

### Blowholes due to Agitations.

In spite of all the precautions the moulder can take, large volumes of gas and steam are generated when the metal enters the mould, and means must be provided whereby these gases can escape easily to the atmosphere rather than into the steel. It is unnecessary to stress here the importance of providing adequate vents and artificial passage-ways for the steam to escape, but mention should be made of one common fallacy. That is, that coarse sands are "open" and free-venting, while fine ones are "close." This does not necessarily follow. There is a well-known illustration of the point, consisting of a number of jars of exactly equal size, some of which are filled with balls of the same size, but varying from jar to jar, while one is filled with a few balls of each of the sizes. The spaces left between the balls are then filled with water, and in every case it is found that the jars containing balls all of one size will hold much more water than the jar containing a mixture of balls. Obviously, therefore, the important thing is to use a sand of uniform grain size rather than a coarse sand containing many finer grains.

The evils of excessive sleeking and finishing in a mould are well known. The trouble is caused by the capillary attraction of the sleeking-tool passing over the face of the sand drawing up the moisture in the sand. This water brings with it a quantity of the clay bond in the sand, and when the mould is dried this forms a layer as impervious as concrete to the passage of steam or gas. The gases then try to find a vent through the metal, and blowholes are the result. Also the expansion of the hard surface layer under heat forces off some of the sand, causing scabs and dirty castings. In the case of green moulds the water collected in the face evaporates, and unless there is free exit for it through the sand, blowholes result again.

Under the last heading the holes or cavities are a result of the very high temperature of the steel and of the short liquid range available. As a result of this the moulder tends to rush the metal into the mould as quickly as possible. This is quite permissible where the volume of the mould is such as to allow the still-liquid metal in the casting to adjust itself, but where the shape is complicated and of varying section entrapped gases often result. Some time ago a number of experiments were made to demonstrate this, but unfortunately the photographs are not good enough for reproduction, so that an attempt has been made to show the results diagrammatically. Fig. 18 shows the middle test of a series of deliberate short-runs; the test-piece consisted of a flat plate with a number of bosses; the moulds were prepared, and pouring stopped when the moulds were one-quarter, half and three-quarters full. In each the result was a section similar to the one shown. It is assumed that the velocity of the metal was such as to push the liquid level to the top of the edges shown, but that immediately the pressure was removed, owing to cessation of pouring, the liquid in the centre sank back to a common level. This action is somewhat complicated by the metal freezing, but this was in some degree a help, as it showed that in the sections at the extreme end the metal tended to have a higher level at the edges than in the centre. In Fig. 19 is shown a hypothetical mould at the moment when it is completely full. There is a definite downward pressure in the runner, and an upward pressure in the casting. Immediately pouring ceases the metal loses its velocity, and the pressure is reversed as shown in Fig. 20. The liquid seeks a common level, but the metal which has been in contact with the top face of the mould is frozen solid, so that a cavity is formed immediately beneath, unless, of course, the section is covered by a feeding head. Now suppose the casting has a further projection as shown on the right. The results seem to show that, owing to the high-pouring velocity, the metal will flow to the farthest point and then ascend the outer side of the mould, coming round over the top and trapping a bubble of air. If this action does take place, it explains many very puzzling defects, because, in view of the grading of the section, one would expect the bottom level to be fed quite solid.

### Casting Temperature.

It will be noted that no reference has been made to the effect of the temperature of the liquid steel on the soundness of the casting. This omission is quite deliberate, because it is felt that there is not sufficient accurate data available. Pyrometric readings above 1,100 to 1,200 deg. C. are subject to very large errors (often as much as 150 to 200 deg. C.) owing to the difficulty of high-temperature calibration: in addition it is frequently almost impossible to obtain the necessary "black-body" conditions. Moreover, experience indicates that the actual difference in temperature between what is known as "hot steel" and "sluggish metal" is much less than is commonly supposed, as the time taken in the furnace for the metal to pass from one state to the other is not sufficient to allow any great quantity of heat units to be absorbed.

This question is, of course, closely associated with the vexed problem of fluidity or "flowing-power." The matter has been discussed at great length in purely metallurgical circles, but no very definite conclusions have been reached. It is felt that this is not a suitable time at which to raise the question again. Recently the rotary furnace, fired by pulverised fuel, has been used with some success for steel castings. Perhaps this new process may throw some light on the problems caused by metal which, although appearing very hot and liquid, has very little running power and does not attack the sand of the mould, while metal which appears cool, and may even skull over in open shanks, will easily run into the thinnest sections, and in some cases cause extreme burning-on or fusion of the sand mould.

In view of this the question of temperature has been deliberately omitted, as it is felt that the subject is too controversial to discuss without actual data and statistics.

An attempt has been made to present a few lines of constructive thought on the three most common defects of the steel casting, and while it is realised that there are very obvious omissions it is felt that a study along the lines indicated will yield suggestions covering these omissions. In 1926 a Continental gentleman, writing in The Foundry Trade Journal, said that he "poured 7 tons during 40 minutes and produced all sound castings"!!! No wasters. If this Paper and the discussion enable us to get within sight of that superman the effort will have been well spent.

## International Iron and Steel Standards.

An international conference to standardise iron and steel products was held at Düsseldorf from January 9 to 14, at the invitation of the German Standards Association, and was attended by 45 delegates from Germany, Belgium, Denmark, France, Holland, Italy, Austria, Poland, Sweden, Switzerland and Czecho-Slovakia. Dr. Bünzli (Switzerland) took the chair.

The Swiss Standards Association submitted a draft of the decisions reached at the previous conference held at Prague in October, 1932, which formed the basis of discussion at the present meeting. The principal subjects touched on in the discussion were:—Classification of, and standard terminology for, iron and steel products. Symbols and definitions for use in the practical testing of shapes, bars and sheets. Testing of materials and acceptance tests (standard specifications for the various tests to be applied). Standards for structural steel, shapes, bars, machine parts, and alloy steels. On most points, agreement was reached, and a sub-committee was appointed to prepare a report of the conference and discuss outstanding questions not disposed of at the meeting. For the next conference, to be held within a year, drafts are being prepared for international delivery and acceptance specifications for iron and steel.

**Manganese Deposits of Canada.**—The Dominion Department of Mines at Ottawa has just issued Volume 12 of the Economic Geology Series now in preparation by the Geological Survey, this being a Report by Dr. George Hanson on "Manganese Deposits of Canada." Copies of the Report are available in the Reference Library at Canada House, Trafalgar Square, London, S.W.1. The work of investigating the manganese occurrences in the Maritime Provinces was originally started in 1925 by the late Dr. W. L. Uglow, but suspended owing to his accidental death in 1926. The examination of the Maritime Provinces deposits was taken up by Dr. W. V. Smitheringale, and the present volume, dealing with the Manganese Deposits of Canada is a compilation of this work and of other information available in the Geological Survey as late as the autumn of 1931. Data are given relative to occurrences of manganese ore found in each of the Provinces with the exception of Saskatchewan, as well as those in the North-West Territories and in the Yukon Territory. The known manganese deposits of Canada, however, are confined chiefly to the Maritime Provinces and British Columbia, there being in other parts of Canada only a few small non-commercial bog deposits. Copies of the Report can be obtained by persons interested on application to the Director, Geological Survey, Ottawa (price 20 cents).

# Foundry Costing.

## DISCUSSION.

Mr. A. Young's Paper, published in our last issue, induced an interesting discussion, centreing around the allocation of overhead costs. It was opened by MR. CLAMP, who said that Mr. Young had described a method of costing which probably would be ideal for application to a foundry producing iron castings on a mass-production basis, but if he tried to apply the theories put forward in the Paper to a jobbing-iron foundry he would be hopelessly at sea in many respects. Mr. Young had said that he would allocate on-costs on one basis only, and that he would prefer the basis of direct labour, though he had tried others, including weight. Mr. Clamp suggested that in a jobbing-iron foundry, however, it would be better to compromise rather than to adhere to one basis. If on-costs were divided into two, certain on-costs would be allocated on the gross weight, not the net weight, of castings, but the bulk, in number at any rate, were better allocated on the basis of direct labour. He, personally, was fortunate, in that the men at his foundry were paid piece rates, and were paid a price, as a group, for every job. That was not the common practice throughout the country, however, and in a jobbing foundry where there was no piecework it would be very difficult to get the on-costs on the basis of direct labour, so that one was forced back to the fairly common device—for which Mr. Clamp did not hold a brief, but he did not see much alternative—*i.e.*, a tariff based on the intricacy of the moulding and core making.

### Costing Foundry Equipment.

Another matter which was not quite so clear as Mr. Young had suggested was that of capitalising the moulding boxes, and, presumably, other foundry equipment. Mr. Young had given an illustration of the danger of capitalising equipment when he had spoken of patterns, and one should be very conservative in this matter. There was a tendency during slack times to make foundry equipment, and one was apt to put up the capital and regret it later. Mr. Clamp would prefer to go to the other extreme and value the foundry equipment as scrap; then it was in a sense written down once and for all, because it was never written up. With regard to Mr. Young's advocacy of arriving at the cupola costs on the basis of the net weight of good castings, Mr. Clamp said that that might be quite a good method in a mass-production foundry, but it would not be a good method in most foundries. There could be only one basis of cupola efficiency, and that was good molten metal. The cupola was not concerned with risers, runners and casting defects, but was concerned only with the production of good molten metal, and the efficiency at the cupola stage, not the net weight of good castings, should be the basis of cupola costs.

### Allocation of Breakage Costs.

MR. BEDFORD, dealing with Mr. Young's suggestion that general on-costs should be loaded on to the various jobs on the basis of direct wages, said that costs accountants endeavoured in all cases to load overheads, no matter what overheads they were, on a basis of logic. He pointed to the cost of selling a casting, the cost of transport of the finished article, and similar items, and asked what was the logic which allied those items to direct wages. With regard to breakages, he did not know whether or not Mr. Young included scrap. Assuming that a specific casting, of which a number were being made, was necessarily weak in certain places, by reason of the nature of its design and construction, and that by reason of that inherent weakness quite a large number of breakages occurred in the works, was it fair to charge the breakages as an overhead to the department concerned, as Mr. Young had done? If a casting were inherently weak because of its design, and was subject to more breakage than others, then surely that particular job should stand the cost of breakages.

MR. ELING said it was not always sound to allocate direct to the cost any part that was purchased and cast into the casting. In the range-foundry trade, for instance, such things as screws, nuts and hinge plates were used in this way, and he was afraid that if they were put direct to cost and ignored in the foundry, one would find a very big loss at the end of the year, because sometimes a good many gross of screws and nuts were sent to the foundry for use in the castings, but they became lost, so that one was not recovering them in the costs if they were allocated direct. It was preferable to charge them as manufacturing materials directly to the on-costs and to be sure of recovering them. His experience was that when they were put direct into costs, one would find a very big loss at the end of the year when one made a check to find out how much was recovered for these materials. With regard to moulding boxes, it might be permissible on the occasion of the first outlay to capitalise moulding boxes, but it was his practice to value subsequently-made boxes at scrap prices.

### On-Costs and Estimating.

MR. TEMPLETON, after congratulating Mr. Young upon an admirable Paper, said that although he had not very much experience in the matter, he was inclined to agree that one should first add together the costs of the raw materials, which were very definite costs, and the direct labour—labour employed on moulding, coremaking and dressing—and so arrive at a figure representing the prime cost. Then arose the difficulty of arriving at the percentage of on-cost to add. He always looked at the matter from the point of view of estimating, so that one could quote properly. If one added 100 or 150 per cent. to the prime cost, without careful consideration, one might load one's self with work which was unremunerative, or, on the other hand, one might quote prices so high that no orders at all would be received. He asked for further information from Mr. Young as to the best method of arriving at the proper percentage of overheads to add to the cost of the direct labour and materials.

MR. BUTTERICK, commenting on Mr. Young's reference to charging, in the cost accounts, interest on financial transactions, asked why Mr. Young preferred to treat such interest as a costing item, instead of treating it as a financial transaction. As regards timekeepers' wages and canteen costs, and the suggestion to allocate that on-cost on direct wages, Mr. Butterick asked if it were not preferable to treat timekeepers' wages on the basis of the number of workers, and to deal with canteen costs on the basis of the number of people using the canteen. Finally, with regard to cost-account periods, he asked Mr. Young if he would recommend the period of 12 calendar months, or whether there was any virtue in taking 13 four-week periods.

MR. CLOTHIER, discussing the problem of despatching castings, and making a charge for despatch on the tonnage basis, pointed out that the cost of packing fine and intricate castings, which might weigh little, was likely to be quite high as compared with the cost of packing and despatching simple and heavier castings, which one man could load. If despatch costs were charged on the tonnage basis, the charge in respect of these intricate castings might be as low as 6d. per cwt., whereas, in fact, they might have cost quite a lot to pack and despatch, and might have involved handling by two or three men.

The CHAIRMAN, who emphasised the importance of cost accounts for the purpose of quoting for future work, said it seemed to him that the allocation of on-costs and so forth depended entirely on what the output was likely to be during the coming year or whatever the costing period was. He asked for Mr. Young's recommendations as to the allocation of on-costs and overhead charges, at the end of a costing period, on work which had been estimated for future delivery. Would Mr. Young recommend working on the basis of what had gone, or would he endeavour to make an estimate of what the output of the foundry would be in the coming costing period, and divide on-costs over the cost of material and direct wages, which cost could easily be calculated from the estimated output?

### The Author's Reply.

MR. YOUNG, replying to Mr. Clamp's question as to whether on-costs should be based on direct wages or whether a compromise should be adopted, said that during the reading of his Paper he might have mentioned that he had had experience of foundries where the two systems were worked side by side and had been found to be suitable. He did not favour it, however, as a general rule, though it might be necessary in some cases. The difficulty about basing on-costs on weight was that weight had no relation to the actual value of the castings. In one casting a good deal of very intricate core-making might be necessary, whereas in another casting, of the same weight, there might be little core-making. If on-costs were allocated on the basis of weight, it followed that each of those castings would carry the same amount of on-costs, which was obviously unfair. If one casting were more difficult and more expensive to produce than another, then it should carry a greater share of the on-costs.

With regard to moulding boxes, he said that when he had written the Paper, he had had in mind the fairly big moulding boxes, and the remarks made in the Paper concerning this matter more or less covered the point which Mr. Clamp had made. Probably he should have added that the replacement of moulding boxes should be charged on the on-costs. In one foundry at which he had been employed it had been the practice to re-value the moulding boxes each year, but they were always valued at more or less scrap value—the value of the wages paid in producing them, and the cost of the metal used was all that was taken into account. In his opening remarks on the subject he was referring to special moulding boxes in a foundry where there was no equipment with which to make them, and where they had to be bought; those should be capitalised. There was no doubt, of course, that the cost of maintenance, depreciation and replacement of moulding boxes should be charged to on-costs.

### Cost of Metal at the Spout.

There was a good deal of diversity of opinion as to whether or not the cost of metal should be based on the weight of good castings produced. When people advocated costing on the basis of the metal at the spout he always wanted to ask them how they were going to arrive at the weight accurately. An American authority on foundry costing had said that one should cost the metal at the cupola spout, but he had added that it should be made perfectly clear that the cost obtained was not that of the molten metal as it left the spout, but the cost of the metal forming the casting, after adjustment was made for excess metal and scrap returned to the cupola for re-melting. In other words, said Mr. Young, one was thrown back on to the cost of good castings, and one must come back to that basis eventually. He was aware, of course, that

XUM

in some foundries, when estimates were being made for a particular job, the foreman was asked how much metal he would require for that job, and he would estimate 3 or 12 bogies, or whatever the number might be. Costs could not be accurate if they were built up on such information as that, and it was more reliable to get back to the actual weight of good castings.

Discussing Mr. Bedford's objection to expressing general on-costs as a percentage of direct wages, Mr. Young said that here again the argument he had used in connection with Mr. Clamp's question applied. Generally, on-costs could not be allocated on a weight basis, because some castings were more intricate than others of the same weight, and the amount of direct wages spent in producing them might be much greater. It was only fair that the more expensive castings should bear a proportionately higher percentage of general on-cost, and in his view the direct wages was the most equitable basis on which to express general on-costs. He had not said that the cost of warehousing *should* be expressed as a percentage in general on-costs, but that it *might* be. The problem of warehousing, loading and despatching costs was really one for domestic consideration, and it was quite impossible to arrive at a general law. Some goods had to be carefully handled and warehoused, and must be kept warm and dry, whereas others required little or no attention. For example, a manhole cover needed no attention in this respect, whereas, on the other hand, goods which were ground and highly polished must be greased and kept dry. It would be absolutely unfair to charge the cost of warehousing and handling these different types of castings on the same basis. It might be useful to base these costs on direct wages, in view of the difference in the values of the castings, but each management should decide the matter in the light of the circumstances of its own productions.

### Breakage Costing.

The allocation of the cost of breakages was a matter which gave rise to a good deal of argument among managers of the different departments. The most simple method, of course, was to charge the cost of breakage to the department in which the breakage occurred; but, as Mr. Bedford had pointed out, the breakage might be due to an inherent weakness in the casting, and, therefore, the charge should be made to the foundry and not to the department in which the breakage occurred. That, of course, was another matter to be decided by the management. The main point was to ensure that the costs of all breakages were covered by the on-costs. His experience with regard to cast-in screws, etc., was the same as that of Mr. Eling, that their cost should be reckoned as on-cost. Any screws which were added later would be included as direct materials. At any rate, he had found that practice applied, though, of course, it might be subject to qualification.

Commenting on Mr. Templeton's remarks, he said that the costing system produced information to enable the management to arrive at the cost of the job, based on the figures for the previous period. The management should be in a position to know whether or not that period was a normal period, and whether or not the percentages of on-cost were fair and reasonable. They should then be in a position to estimate. One or two adjustments might be necessary, of course; for example, it might be found that the price of some of the material had fallen, or that wages were lower. Then they could consider the total burden of overheads provided for in the on-costs. For example, provision might have been made for rent, although the management actually owned the premises; on that account they knew that they could sacrifice a certain amount of on-costs—but they must be very careful not to sacrifice too much. There was a certain line beyond which it was not safe to go when quoting for a job below the estimated cost. The management had to consider such matters, as well as the condition of the order-book, which latter had very often an important bearing on the decisions arrived at. Interest on capital was in the ordinary way a charge on the financial accounts, but where money was borrowed for the purpose of installing certain plant, the interest on it should be charged as an on-cost.

With regard to time-keepers' wages and the cost of running a canteen, it was difficult to advise any other allocation than to the works section of general on-costs. There was no doubt that it was advisable to allocate as much as possible of the on-costs direct to the producing departments, and the wages of time-keepers and store-keepers, and the incidental costs of running the canteen might be allocated to the producing departments on the basis of the wages paid in those departments; but it made no difference really. These costs had to be recovered somewhere, and, after all, the works could produce without a time-keeper and without a canteen, so that he considered that general on-costs was the proper place for these charges. A period of 12 months was perhaps the most suitable costing period, and he did not advise four-week periods. As an example of the reasons for this, he said that one did not re-line a cupola every month, for instance, but probably only once or twice a year, and if the costs were spread over a year, one obtained a more equitable recovery of overheads and maintenance. At his works they were, in fact, adopting three-month periods, but the figure obtained at the end of the year was the most reliable.

Replying to the chairman, he said it was for the management to decide whether or not the period on which on-costs were based was a normal period, and whether it would be possible to reduce on-costs during the current period. In accordance with that decision, they could adjust the percentage of on-costs.

### A Vote of Thanks.

Mr. V. C. Faulkner (Past-President of the Institute), proposing a vote of thanks to Mr. Young, said that the members of the Branch were particularly indebted to him because a lecturer on the question of costing had to face the same difficulty as a lecturer on politics, *i.e.*, that the audience already held preconceived notions, and the lecturer had first to overcome those and then superimpose his own. The lecture on this occasion had led some of the audience at least to think more kindly of the opposition, even if it had not actually convinced them.

Mr. H. O. Slater (Past-President of the London Branch) said that the problem of costing had been before the London Branch frequently during the last twelve years, and Mr. Young's Paper was one of the most enlightening that had been presented. It was gratifying to note that very few of the audience disagreed with Mr. Clamp's view that moulding boxes should be charged at scrap prices—judging, at any rate, by the expressions on their faces. It was a matter for the administrative authorities to decide what should or should not be allocated to indirect labour. It was very difficult to set down hard-and-fast rules on costing, but it had been the endeavour to set down certain principles which would serve as a guide to foundries generally, with modifications in their application to different circumstances.

The vote of thanks was accorded with acclamation.

### Written Contribution.

In a written contribution Mr. E. A. Godman, A.C.W.A., adds: During the course of his remarks the lecturer mentioned that, in his opinion, the best method of distributing general on-cost was by means of a percentage on direct wages. While this may be simple, it does not appear to be equitable, except in instances where rates of wages are uniform throughout the works. In all other cases, departments employing high-rated labour would be penalised. The logical method would seem to be a rate per hour for each department, for in this way the factor of time is taken into account and the cost of running each department obtained more accurately.

## Drilling Square Holes in Castings.

By Vallische.

It is very doubtful if there are many engineers who really know how to drill a square hole. Although such an operation is seldom called for, it is very useful at times. The writer calls to mind the case of a very intricate casting, through one side of which should have been cast three ½-inch square holes. These holes had, unfortunately, been omitted, and considering that otherwise the casting appeared perfect in every detail and had taken almost ten days to mould, the supervisor in charge was loath to scrap it. The idea was to drill three ½-in. diameter holes in the required positions and then chip out the corners to form a square. The holes, however, were nearly 6 in. through and consequently would prove no easy task for the man with the chisel. Someone then came forward with the following idea for drilling a square hole, and although the method is not claimed to be original, the writer feels sure that it will be quite new to many readers.

The very first procedure is to make a former to drill from. This can be made from a piece of steel of convenient size and thickness. In this particular case a piece of steel a quarter-inch thick was used and through the centre was drilled a half-inch diameter hole. The hole was then filed out square. It should be pointed out, however, that had a slightly smaller drill been used (say $\frac{7}{16}$ in. or $\frac{15}{32}$ in.) better results would have been obtained. A smaller drill gives one a better chance of filing out an accurate square, whereas with a drill the same size as the square one is apt to get the square slightly on the large size. However, this operation completed, the next thing is to harden and temper the former, and when it is ready for use the former must now be fastened to the casting in the exact place required. This may be done by soldering, but by far the best method is to secure the former to the casting by electric welding. No pre-heating of the casting is, of course, necessary, and after the holes are drilled the former can be either chipped or planed off. A portable grinder will then smooth the face and no one is the wiser (especially if the casting is afterwards painted). It is, of course, necessary to make a former for each hole in this method, but unless there are a quantity of holes to drill it is the better and surer method.

The next step is to make the drills, but before doing this there must be drilled a half-inch dia. hole through the casting, using the former as a guide. We now take a piece of ½-in. triangular (three-sided) steel. One end (the cutting end) must be hardened and tempered, and the other end must be centred. The cutting end is then put on the grinder and ground absolutely flat and square, at the same time giving each of the three sides the necessary clearance. The drill is now ready for use.

If the drilling machine has no automatic feed, great care should be taken with the hand feed. This should be applied slightly slower and steadier than when using an ordinary twist drill. The combined action of the drill and former will no doubt be easily understood. The round hole in the casting is "squared out" as the special drill with its three corners alternately go into the corners of the former. With this method an almost perfectly drilled square hole is obtained, and is far from being a makeshift method. The writer understands that this method has been used for at least 30 years in some engineering shops, and yet it may be quite new to many.

## The Scrap-Metal Position.

By "Onlooker."

At the recent Woolwich sale of surplus Government material and condemned stores relatively high prices were again paid for scrap brass and copper, and the trade is, as usual, asking how it is that dealers are prepared to put such a high value on this material. The most obvious answer to this query is that some sales have been made "bare," *i.e.*, orders have been taken for forward delivery in the hope that in due course a lower market will provide the opportunity to secure the necessary cover. This explanation was probably sound enough some months ago when copper had a definite downward drift, but to-day with electro at 5 cents it is difficult to visualise much decline in the quotation.

Some other reason must therefore be sought for this readiness on the part of merchants to pay well up to the hilt for scrap metals, and, as far as the Woolwich material is concerned, it is probably due to the comparative scarcity of the better grades of best select copper. This, in turn, may be ascribed to foreign metal being kept out through fear of a duty, and the fact that apart from the output of the Prescot refinery there is no fresh source of Empire fire-refined metal in sight. Government scrap is, of course, of known purity and mixture, such material as Q.F. brass shell cases, for example, being in every way suitable for use in the manufacture of those products normally made from refined copper and high-grade zinc. Moreover, the merchant selling cartridge metal to a customer has no fear of complaints or rejections, and he can therefore afford to base on a fairly small margin of profit.

There is, however, another factor operating which is keeping values of scrap relatively high, and that is the steady demand from the Continent, which is taking quite a lot of old brass out of this country. Prices are being paid which English consumers certainly cannot consider, but merchants here cannot be blamed for making hay while the sun shines, while the first holders of the scrap certainly do not worry whether the scrap leaves the country or not so long as they can net a good price. True, this Continental inquiry is mainly for the lower grades of old metal, but this imparts a firmer tendency to the better qualities and is compelling a certain amount of inflation in scrap metal generally.

It cannot be said that there is a shortage of scrap, and, indeed, some grades of copper are definitely in excess of demand, but any improvement in trade would probably show up a scarcity of some classes of brass. Nevertheless, material is certainly not being pressed for sale just now, and there is every indication that values have reached a level at which holders are prepared to withdraw from the market rather than turn their stock into money. The scrap fraternity is in effect becoming a law unto itself and declining to be led into making low-priced sales just because the producers of primary metals are cutting each other's throats in an endeavour to dispose of their products. There must, of course, be a level at which recovery of old metal is no longer a paying proposition just in the same way as mining of virgin metal is not an economic proposition when the quotation falls too low. Last July, when copper was £5 per ton lower than it is to-day, offers of scrap were negligible except at prices but little below those now ruling, and should the quotation for the red metal again decline, a similar state of affairs would obtain once more.

These symptoms of independence on the part of scrap metals are all to the good, and indicate a healthy state of affairs, inasmuch as selling pressure is absent and stocks are being carried without depressing values. Here and there distress sales may be reported at cut prices, but, broadly speaking, dealers in old metals are showing a sturdy independence which augurs well for the future of the trade.

## Electric Drive *v.* Gas Engine.

### A COMPARISON OF COSTS.

By Kilowatt.

The question frequently arises as to whether it is cheaper to utilise the gas engine as a form of prime mover or take a supply of electricity and instal electrical drive. With the rapid growth of electric supply in this country and the publicity given to the completion of the "Grid" which is to bring a cheap and abundant supply to every home and factory, it would appear that there can be no room for doubt and that the universal adoption of the electric drive is a foregone conclusion. If and when the "grid" offers the manufacturer electric power at an all-in rate of ½d. per unit then founders need have no hesitation in driving their plant electrically, but in the meanwhile they must utilise alternative forms of power if they are satisfied that such are cheaper and equally efficient.

It is, of course, impossible to lay down any hard and fast rule as to when the gas engine is cheaper than the electric motor as existing local conditions must have an influence on the merits of each individual case. For example, although it may clearly be shown that the cost of electric drive in a factory would exceed that of a gas engine by, say, £200 per annum, it may be that the secondary advantages obtained from electricity, such as adaptability of lay-out through application of individual drive, necessity of presence of prime mover in dangerous situations, may outweigh the additional costs incurred.

There are, however, straightforward cases where the question to decide is the installation of one central form of prime mover and here we can carefully compare costs. Take the case of a plant, working 10 hours per day for 300 days per year, requiring, say, 60 h.p. to drive it, and the cost of local electric supply is 1½d. per unit, against gas at 8d. per therm. Now the ultimate economy of any form of power depends on two main factors, capital expenditure and revenue expenditure.

In assessing each of these, all contributory factors must be taken into account in order to make a true comparison. Capital expenditure consists in the case of electric power of (1) total cost of motors and control gear; (2) cost of transmission equipment; (3) electric supply company's charges for laying cable; and (4) cost of erection, testing and setting to work.

With the case of a gas engine the factors comprise (1) the total cost of the engine and auxiliary equipment, including producer equipment in the case of a suction gas plant; (2) foundations; (3) piping and water tanks or water re-cooling apparatus; (4) cost of transmission equipment; (5) cost of erection, testing and setting to work. From the considerable variations which are possible in the factors which comprise total capital expenditure, it can be seen that the cost of the motors or engines ex-maker's works is by no means a correct basis for direct comparison.

Revenue expenditure consists not only of the cost of electric current or fuel, but also of maintenance, repairs and replacements, attendant's time, a standing annual charge which comprises interest on capital invested, depreciation, insurance and the rental and rateable value of the portion of premises occupied.

Excepting the case where the cost of laying a new electric cable and erecting buildings is very high, it is frequently found, taking all things into consideration, that the electrical installation is the cheaper in first cost. Against this, the gas engine is almost always the cheaper in revenue expenditure, due to the direct conversion of fuel to mechanical power, instead of the three stages of fuel, namely, dynamo, dynamo via switchboard and cables to motor, and motors to mechanical power.

The comparative standing charge of interest on capital is, of course, determined by the comparative capital costs of the power units under review. Depreciation charges may be based on writing off the capital cost in, say twelve to fifteen years in the case of engines and a slightly longer period in the case of motors. Assume, therefore, a total standing charge for interest, depreciation, insurance, etc., of 17 per cent. for motors. The constant attention required in the operation of an engine as compared with an electric motor is certainly a point in favour of the motor. This is generally more than counterbalanced by the low fuel cost per horse-power of an engine when compared with the current cost per horse-power of an electric motor. A current cost of 1½d. per unit with an electrical efficiency of 85 per cent. is equivalent to approximately 1½d. per b.h.p. per hr., or 6s. 8d. per hr. for 60 b.h.p. A gas engine of efficient design, consuming town gas at 8d. per therm, would cost 0.7d. per b.h.p. per hr., or 3s. 6d. per hr. for 60 b.h.p. for gas.

With a daily working period of 10 hrs. per day for 300 days per year the current cost in the case of electricity would, therefore, be £1,000 per annum. The cost of gas for the same power would be £525, giving a gross difference in favour of gas of £475. This sum will, of course, be diminished by the cost of additional share of attendant's time, extra maintenance and repairs required. In the case of an engine this would amount to, say, £85 extra per annum, which reduces the saving in running costs to £390. This saving in revenue expenditure may be further diminished by the additional allowances necessary for interest and depreciation on the gas-engine installation, if this is higher in total capacity outlay. In this particular case it is fairly clear that, when considering all these points, the gas-engine installation would be by far the more economical of the two forms of power.

The above particular example, while purely hypothetical, may serve as a basis on which the power user can build up his own comparative tables.

## More Christmas Presents.

In addition to the list of calendars, etc., recorded in our Annual Review Number, we have received from the Stabilimento Grandi Motori F.I.A.T., of 20, Via Cunio, Torino (Turin), Italy, a monthly tear-off calendar. This has been in our possession several days, and we confess to an ever-increasing admiration. It is carried out in a delicate shade of blue, which, in an office painted in dead white, such as is general in Italy, it would stand out to perfection. In a London climate, with a prevalence of artificial light, it loses a little of its beauty. It is printed in English, and at least three-colour printing has been used. The paper is very thick and carries a stipple or dotted effect. We congratulate the publicity department of the F.I.A.T. concern in having produced something really artistic and out of the ordinary.

The I.C.I. (Metals), Limited, Millbank, London, S.W.1, have sent us a pocket and desk diary. The latter is three days to a page, and represents the acme of perfection in lay-out, appearance and utility.

Messrs. Hughes, Bolckow, the Blyth firm of ship-breakers, have sold to a Japanese firm the steamer "Stanleyville," which they recently purchased from the Compagnie Belge du Congo. Col. Harrison, general manager of the company, stated that the steamer had been sold because the company did not benefit by selling scrap in this country, where the prices were so low that they were forced to sell abroad. He believed there was a good deal of scrap being exported from this country owing to the present state of affairs.

# This Week's News in Brief.

## Trade Talk.

THE NUMBER of balanced-blast cupolas in operation or under construction is 27, yielding a total hourly capacity of 170 tons per hr.

MESSRS. R. & W. HAWTHORN, LESLIE & COMPANY, LIMITED, Newcastle, have completed two Diesel locomotives to be employed on the Sudan Government Railways.

THE NEW CARGO STEAMER "Hardingham," built by Messrs. Lithgows, Limited, Port Glasgow, for Messrs. J. & C. Harrison, Limited, London, has run very successful trials on the Clyde.

THE SOUTHERN RAILWAY COMPANY has placed orders for 5,000 tons of chairs with Messrs. Pease & Partners, Limited, Middlesbrough, and for 2,000 tons of chairs with the Tees-side Bridge & Engineering Works, Limited.

IN AN EFFORT to attract new industries to Tyneside a number of Northern business men have launched a scheme proposing the formation of a company with a capital of £20,000 to help in the flotation of new businesses.

THE PRESIDENT OF THE BOARD OF TRADE has appointed a committee to report whether any, and if so what, changes in the existing law and practice relating to trade marks are desirable. Viscount Goschen is chairman of the committee.

MESSRS. CRAVEN BROS. (MANCHESTER), LIMITED, during January delivered three of their electrically-driven square ingot-turning lathes, an electrically-driven trepanning and drilling machine, and a locomotive axle journal re-turning lathe.

MESSRS. DRYSDALE & COMPANY, LIMITED, of Yoker, Glasgow, the well-known makers of centrifugal pumps, have recently put on the market a novel design of centrifugal pump of the self-priming type, which would appear to offer considerable advantages.

CONSIDERABLE DAMAGE was done by a fire that burnt out the pattern-making shops at the marine engineering and turbine works of Messrs. Richardsons, Westgarth & Company, Limited, Hartlepool, recently. Arrangements have been made to carry on business as usual.

THE CARRON WORKS employees' infirmaries fund have allocated £2,006 for 1932. £1,210 of which has been allocated to Falkirk new Royal Infirmary. The employees of Messrs. Butters Bros. & Company, Limited, M'Lellan Street, Glasgow, have contributed £58 to various charitable institutions.

THE FOLLOWING FIRMS have taken out licences for the manufacture of Silal and Nicrosilal :—James Hodgkinson (Salford), Limited, Manchester; George Kent, Limited, Luton; Robey & Company, Limited, Lincoln; Vickers-Armstrongs, Limited, Barrow-in-Furness; and Yorkshire Repetition Castings Company, Limited, Bradford.

THE FOLLOWING FIRMS have recently joined the British Cast Iron Research Association. Their official representatives are given in brackets :—Bayliss, Jones & Bayliss, Limited, Wolverhampton (Mr. P. S. Bayliss); the Cardiff Foundry & Engineering Company, Limited, Cardiff (Mr. Eugene Curran); Grimwade & Allen, Footscray, Victoria, Australia (Mr. W. L. Allen); Thomas Perry & Sons, Limited, Bilston, Staffs (Mr. W. H. Lewis); and John Williams & Sons (Cardiff), Limited, Cardiff (Mr. C. E. Williams).

PATTERNS WERE DESTROYED and damage done to buildings in the works of Messrs. Babcock & Wilcox, Limited, Renfrew, last week by fire. The outbreak occurred in a shed used for the storage of patterns, and, owing to the inflammable nature of the contents, the fire burnt very fiercely, and the firemen had to confine attention to other buildings in the vicinity. The fire was kept to the shed, and the damage, which will not interfere with the working the firm, is estimated at £1,000. Arrangements have been made to carry on business as usual.

WORK HAS BEEN RESUMED at the carbonisation plant at Glenboig, which was originally owned by the Bussey Coal Distillation Company, Limited, and transferred to Scottish Gas Utilities Corporation, Limited, London, last September. For some months constructional engineers have been engaged preparing for the resumption of output, and there has been evidence of activity in the works, although those in charge have been reticent as to what was going on. It is now learned that shifts of workmen in groups of 30 are engaged in the production and gas is being supplied to a local manufacturing firm, whilst oil and ammonia are also being produced.

## Obituary.

MR. JOHN MORRIS DRIVER, director of Messrs. William Driver & Sons, Limited, nail and rivet manufacturers and iron and steel merchants, of Silsden, Keighley, has died at the age of 76 years.

MR. WILLIAM BAILEY, of Penrith, who had been in the employ of a Penrith firm of ironfounders for about 75 years, died on Monday in his 89th year. He was the oldest moulder in the country, and, although pensioned, continued to do odd jobs at the foundry.

MR. ANDREW JOHN MATHER, formerly managing director of the Bowling Ironworks, Bradford, has died at the age of 82 years. He became assistant manager at the Bowling Ironworks 42 years ago, and subsequently was appointed managing director, retiring in 1920.

WE REGRET TO ANNOUNCE the death of Mr. William Steel, who for the last eight years has been associated with the Suffolk Iron Foundry as their welding engineer. Mr. Steel was the author of an interesting Paper on the welding of cast iron, which he presented to the London Branch of the Institute of British Foundrymen some four years ago.

FOR OVER FIFTY YEARS an employee in the costing department to the Cannon Ironfoundries, Bilston, Staffs, Mr. George Daniel Lloyd, of 20, Mount Pleasant Street, Coseley, died on February 3, aged sixty-eight. He was last year the recipient of gifts from the directors of the firm, and from the staff, upon the completion of his half a century of service.

THE DEATH OCCURRED on January 29, at the age of 86, of Mr. Richard Round, of Holly Hall, Dudley, Worcs. All his working life Mr. Round was employed at the Hart's Hill Works of Messrs. Hill & Smith, Limited, ironfounders, of Dudley, where he was cashier for a long period. When he reached the age of eighty, he retired on pension, having completed 65 years' service at the firm.

THE DEATH OCCURRED on January 28, at Tonbridge, Kent, of Mr. Andrew Pitcairn Henderson, a prominent Clyde engineer and shipbuilder. Mr. Henderson, who was in his 82nd year, was a director of the firm of Messrs. D. & W. Henderson & Company, Limited. He was principally interested in the engineering side of the business, and in 1901 became chairman of the firm, and remained in that position until about 1917, when he retired, and his cousin, Sir Frederick Henderson, succeeded him.

MR. ALFRED HAROLD WIGGIN, of Bordesley Hall, Alvechurch, who was for many years prominently identified with the industrial affairs of Birmingham, and was a well-known figure in the public life of Worcestershire, died on Sunday, January 29. Born on January 20, 1864, Mr. Wiggin was the third son of the late Sir Henry Wiggin, Bt. He joined the firm of Henry Wiggin & Company, nickel refiners, of Birmingham, in 1887, and was for many years managing director of the company. For nearly thirty years he was a director of the Midland Railway Company, and later of the London Midland & Scottish Railway Company. He was also at one time a director of Muntz's Metal Company and Elliott's Metal Company. A magistrate for Worcestershire for forty years, he was at one time chairman of the Halesowen Bench, and he was High Sheriff of Worcestershire in 1924.

THE DEATH OCCURRED suddenly on January 28, at his home in Cambuslang, near Glasgow, of Mr. Thomas Killin, J.P., for many years with Messrs. William Baird & Company, Limited, Coatbridge. Mr. Killin was one of the most enthusiastic members of the Burns movement in Scotland; he was a native of Mauchline, and as a lad had talked to several people who knew Burns personally. Mr. Killin was over 80 years of age, and in his business career had the remarkable record of 57 years' active service with one firm, Messrs. William Baird & Company, Limited, ironmasters, Gartsherrie and elsewhere. As a young man he went to the Lugar works for the firm, a position he held for four and a-half years, when he was appointed outside superintendent in Glasgow, a position he held for more than 52 years. Mr. Killin was the first student to attain the Associateship in Metallurgy of what is now known as the Royal Technical College, Glasgow. As a young man he took first prize in the United Kingdom and a silver medal in the honours fuel examinations of the City and Guilds of London Institute.

## Personal.

AFTER COMPLETING more than 57 years' service with Newton, Chambers & Company, Limited, Thorncliffe Iron Works, near Sheffield, Mr. F. Cooney has retired. Starting in a minor position in 1875 he remained at the works until 1893, when he was transferred to the Manchester branch, to take charge as engineer of the central heating and cooking apparatus section.

MR. AND MRS. JAMES A. MORRIS, of Ayr, have celebrated their golden wedding, and have been the recipients of many congratulations and gifts. Mr. Morris has had a long and distinguished connection with Ayr, where he has practised as an architect. He is also the chairman of Messrs. Glenfield & Kennedy, Limited, Kilmarnock. Mr. Morris is a Burns enthusiast, and supervised the work of restoration of the Auld Brig of Ayr, which was carried out as a result of the late Lord Rosebery's world-wide appeal to Burns lovers for the necessary funds.

## Phosphorus in Cast Iron.

(*Concluded from page* 105.)

### Phosphorus and Keep's Test.

So many factors are involved in the carrying out of this test and which can affect the results that many workers do not consider the results obtained therefrom of much importance. The results, however, in this case are comparative and are given for interest's sake only. An increase of phosphorus content in these experiments have caused a reduction in the total contraction which is not inconsiderable, and is worthy of note. The results obtained from the chill-test sections cut from the Keep's test-bars are but a confirmation of the value of low phosphorus irons to the chill roll makers.

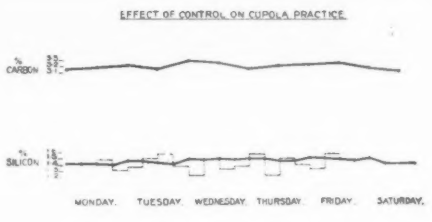



FIG. 11.—ONE WEEK'S CONTROL OF CARBON AND SILICON CONTENT.

### Summary.

It can be fairly conclusively claimed that the results show that phosphorus in cast iron gives rise to an extended range of solidification, and in this way becomes responsible for defects such as drawn holes and sponginess in castings of varying sectional thicknesses. A limitation of its presence to under 0.30 per cent. has a very beneficial effect upon the soundness of the resulting castings. When considering the balance and effect of total carbon and silicon in a mixture of cast iron it becomes of utmost importance to take into account the percentage of phosphorus present in the mixture.

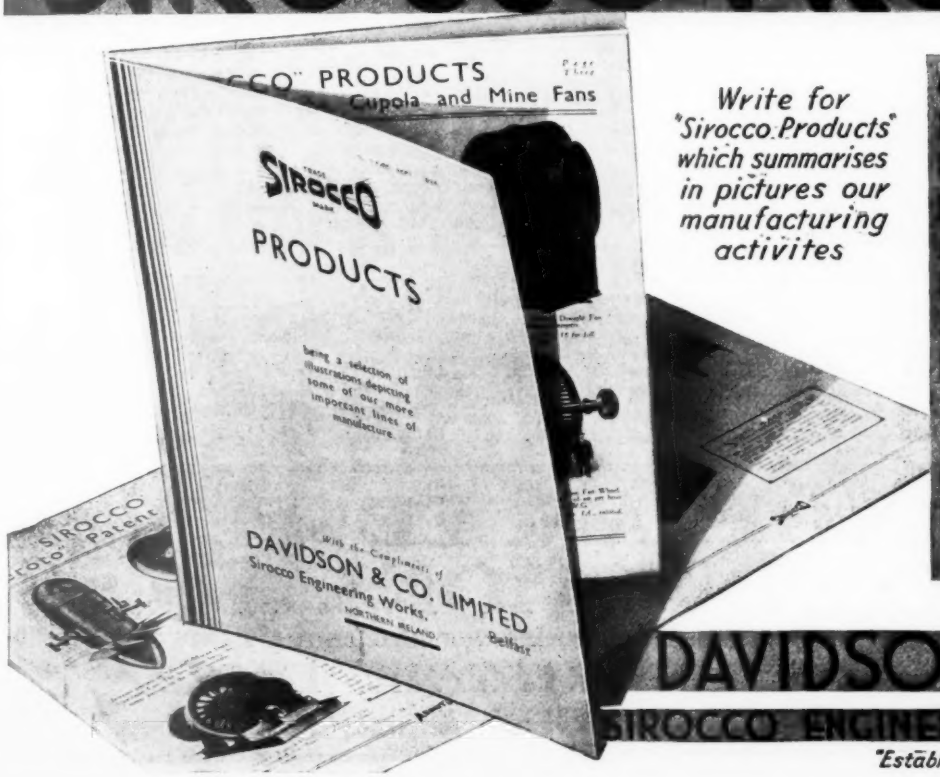
MESSRS. BAYLISS, JONES & BAYLISS, LIMITED, Monmoor Works, Wolverhampton, have appointed Mr. C. A. Parson, 111, New Street, Birmingham, as their representative in the Midlands for the sale of steel bars. Their Mr. C. A. Parson already represents allied companies, Messrs. Guest, Keen & Nettlefolds, Limited, Darlaston; Messrs. Guest, Keen & Nettlefolds, Limited, Rogerstone Works; Messrs. Joseph Sankey & Sons, Limited, Bilston; and Messrs. John Garrington & Sons, Limited, of Darlaston.

# PIG IRON

Manufacturers of FOUNDRY, BASIC and HEMATITE qualities. Delivery from stock.
Booklet giving analyses, etc., will be sent on request.
DORMAN LONG & CO. LTD., MIDDLESBROUGH

## DORMAN LONG

# 'SIROCCO' PRODUCTS




*Write for "Sirocco Products" which summarises in pictures our manufacturing activites*

Centrifugal & Propeller Fans. Aeroto (trade mark) Patent Screw Fans. Air Heaters, Washers and Automatic Air Conditioning Units. "Davidson" dust & flue dust Collectors. Pneumatic Conveying Plant etc. etc.

OUR ACCUMULATED EXPERIENCE IS AT YOUR SERVICE.

## DAVIDSON & CO. LTD.

SIROCCO ENGINEERING WORKS, BELFAST

*"Established in 1881"*

# Raw Material Markets.

Sellers of iron and steel material continue to experience a fairly steady volume of orders, but the latter are generally on the small side and there is no sign of the expansion in demand which was expected. A favourable sign, however, is the improvement in the shipbuilding situation. Although the several new vessels ordered have only been of small and medium size, they will mean a welcome accession of activity to many long-empty yards. A number of important naval shipbuilding contracts have also been placed.

The demand for pig-iron and for finished and semi-finished steel remains on steady lines. Scrap iron continues to be a strong market, but the same cannot be said of the base metals—copper, tin, spelter and lead—which continue to be in a poor position.

## Pig-Iron.

**MIDDLESBROUGH.**—The reluctance on the part of consumers to pay the increased prices for Cleveland iron has somewhat limited business, but more activity should be shown when the new conditions have been fully tested, especially as the increases took the market largely by surprise, and there was little laying-up of stocks at the old levels. The ironmasters are emphasising the fact that the 4s. per ton increase in the quotation for No. 3 G.M.B., which is now at 62s. 6d., delivered, as regards the Tees-side area, includes on an average a freight charge of about 2s., the actual f.o.t. price now being about 60s. 6d. All quotations remain unchanged. No. 1 Cleveland foundry iron being at 65s. and No. 4 foundry or forge at 61s. 6d., delivered locally.

East Coast hematite continues to hold a price advantage over other Cleveland irons, and a steady demand is being experienced. Substantial shipments have lately been made, particularly to the South Wales steelmakers. Prices are a trifle unsteady, there still being a small surplus of output. Officially, however, quotations are still unchanged at 59s. per ton for mixed numbers and 59s. 6d. for No. 1 quality.

**LANCASHIRE.**—The consumption of foundry iron in this district remains at about recent levels, there being little improvement in general industrial conditions in the district. The agreement between Midlands and Cleveland pig-iron producers merely stabilised the existing position as far as Lancashire is concerned. Derbyshire and Staffordshire brands of No. 3 foundry iron are quoted for delivery to users in the Manchester price zone on the basis of 67s. per ton, Northamptonshire being on offer at 65s. 6d., Derbyshire forge iron at 62s. to 63s., Scottish foundry at around 82s. and East and West Coast hematite at about 75s. 6d. and 80s. 6d. per ton respectively.

**MIDLANDS.**—Conditions in the pig-iron market fail to show improvement. The recent setback in the light-castings industry shows no sign of alleviation at the moment. New orders of any size for pig-iron are scarce, whilst requisitions against current contracts have also shown a slight falling-off. Prices remain at the minimum rates for this district, namely, 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, North Staffordshire and Lincolnshire No. 3, delivered Birmingham and Black Country stations. Moderate quantities of Scottish iron come into South Staffordshire, at from 83s. 6d. to 85s. 6d. per ton, delivered, for No. 3. Continental iron is uncompetitive.

**SCOTLAND.**—Pig-iron consumers are unable to show much activity at the moment, particularly in the heavy-engineering sections. Foundries supplying ship material are very short of work, but there have lately been signs of a slight improvement in this direction. Scottish No. 3 foundry iron has been increased to 70s. per ton, f.o.t. furnaces, with 2s. 6d. extra for No. 1 quality. English brands of pig-iron now stand at much-increased prices. No. 3 Middlesbrough is now at 62s. 9d. delivered Glasgow and 59s. 9d. at Falkirk. Midlands iron has advanced proportionately.

## Coke.

Foundry coke continues to suffer from a very poor demand, consumers being unwilling to contract ahead at the present levels. Prices are unaltered at 36s. 6d. to 38s. delivered Birmingham district for best Durham coke, and from 30s. to 45s., according to analysis, for Welsh coke, also delivered Birmingham. Furnace coke is, perhaps, a little more active, but the demand is still much below the requirements of the makers.

## Steel.

Business has improved during the last few days, although it is not so active as is usual at this season, according to the official report of the London Iron and Steel Exchange. The improvement is partly due to the firmer conditions which have developed in the Continental steel trade as a result of reports that the negotiations for the reconstruction of the European Steel Cartel have been successful. An advance of several shillings in Continental steel prices took place early in the week, and a number of Continental works withdrew from the market. The British works also have experienced more active trading. In the semi-finished steel department buying is still confined to hand-to-mouth quantities, but the demand seems to be expanding, and in the absence of effective Continental competition in the British market the home works are reported to be gradually increasing their production. Business in finished-steel materials has broadened, and export inquiries have become more active after a quiet spell. Export business with Empire markets is reported to be on the increase.

## Scrap.

The demand for scrap iron in the Cleveland area has been stimulated by the rise in pig-iron prices. Merchants are still prepared to do business, however, on the basis of 40s. for ordinary metal and 43s. per ton for good machinery cast-iron scrap. There is increased activity amongst Midlands iron-founders, and a correspondingly good demand for scrap. Heavy machinery metal is offered at 47s. 6d. to 50s. and clean pipe and plate at 40s. Light cast-iron scrap is very scarce at about 37s. 6d. to 40s., delivered works. The demand remains steady in South Wales and prices are practically unchanged. The Scottish foundries are somewhat busier, and are buying machinery metal, in pieces not exceeding 1 cwt., at 47s. 6d. to 50s. For ordinary cast iron 46s. has been paid and in some districts a little more.

## Metals.

**Copper.**—Electrolytic copper has been steady at about 5 cents per lb., c.i.f. Europe. The demand from industrial users fails to show any expansion, the expected revival being as far off as ever. Figures published by the American Bureau of Copper Statistics reveal that the average monthly deliveries of copper into consumption in Great Britain during 1932 totalled 10,306 tons, compared with 9,875 tons in the preceding year. This improvement was accentuated during the last quarter of 1932. Consumption fell away almost generally on the Continent during last year—a small grain of comfort for the British consuming industries. Consumption is also believed to have continued its decline in the United States, but the statistics for 1932 have not been published.

Prices have been :—

*Cash.*—Thursday, £28 10s. to £28 12s. 6d.; Friday, £28 7s. 6d. to £28 10s.; Monday, £28 7s. 6d. to £28 8s. 9d.; Tuesday, £28 8s. 9d. to £28 10s.; Wednesday, £28 11s. 3d. to £28 12s. 6d.

*Three Months.* — Thursday, £28 13s. 9d. to £28 16s. 3d.; Friday, £28 12s. 6d. to £28 13s. 9d.; Monday, £28 12s. 6d. to £28 15s.; Tuesday, £28 13s. 9d. to £28 15s.; Wednesday, £28 15s. to £28 16s. 3d.

**Tin.**—The position of this market has been rather unusual lately. Although, generally speaking, activity is at a low ebb, there has been a corresponding shortage of prompt supplies; this accounts for the recent narrowness of the contango. A major improvement in the demand would almost at once result in a considerable increase in price. A fair demand continues to come from South Wales, where the tinplate mills are reported to be working at up to 70 per cent. of capacity.

Prices of standard tin have been :—

*Cash.*—Thursday, £150 to £150 5s.; Friday, £149 12s. 6d. to £149 15s.; Monday, £149 15s. to £149 17s. 6d.; Tuesday, £149 12s. 6d. to £149 15s.; Wednesday, £148 17s. 6d. to £149 2s. 6d.

*Three Months.* — Thursday, £150 15s. to £151; Friday, £150 5s. to £150 10s.; Monday, £150 7s. 6d. to £150 10s.; Tuesday, £150 to £150 2s. 6d.; Wednesday, £149 7s. 6d. to £149 10s.

**Spelter.**—Consumers of spelter are shy of committing themselves at the moment, and the turnover has been very restricted. Interest is centred upon the efforts being made to revive the Zinc Cartel, which has now ceased to operate. Should success attend the urgent meetings now being held, the market will be considerably strengthened.

Price fluctuations :—

*Ordinary.*—Thursday, £13 11s. 3d.; Friday, £13 10s.; Monday, £13 13s. 9d.; Tuesday, £13 15s.; Wednesday, £13 15s.

**Lead.**—A fairly steady rate of consumption is maintained for this metal, but there is no sign of any expansion of interest, either for early or forward delivery. The efforts now being made to instil activity into the building industry should, if they are successful, have a considerable effect on the situation.

Daily market prices :—

*Soft Foreign (Prompt).*—Thursday, £10 11s. 3d.; Friday, £10 12s. 6d.; Monday, £10 10s.; Tuesday, £10 7s. 6d.; Wednesday, £10 7s. 6d.

---

The Penistone Steelworks, formerly the property of Messrs. Cammell, Laird & Company, Limited, which were closed a few years ago, are to be dismantled. Contracts have been made with Messrs. Thos. W. Ward, Limited, Sheffield, for the immediate dismantling of the plant.

CAST IRON FLANGED PIPES
2 in.—12 in. & CONNECTIONS. to 24 in. dia.
WE HAVE FIFTY-TWO YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.
JAMES & RONALD RITCHIE, LTD.,
Telephone: 3852 (2 Lines). MIDDLESBROUGH. Telegrams: "Ritchie, Middlesbrough."

*Diesel engine piston (6 cwts.) and car piston (9 ozs.) in aluminium alloy, by William Mills, Ltd. The Diesel engine piston is 21½ ins. in diameter in contrast with the car piston of 70mm. diameter.*

# 1.. 2.. 3.. REASONS

In a multitude of fast-moving parts, surplus weight cannot be left to take care of itself. A reduction in weight relieves bearing stresses and thereby reduces friction, it simplifies balance and thereby reduces vibration and noise, it lessens inertia and thereby reduces the energy absorbed in starting and stopping or changing speed.

On these counts alone, the light alloys of aluminium merit consideration, but taken in conjunction with the metal's other properties—its high thermal conductivity, and its ability to withstand fatigue, shock and stress — small wonder that these alloys are commended. Pistons of all types are an example of the ready reception accorded to the light alloys of aluminium where these three factors must be combined, i.e., light weight, sturdy strength and high thermal conductivity.

The B.A. Co.. have in regular production :—
(1) Virgin aluminium (98|99% and higher purities) in notched bars, half round sticks, rolling slabs, billets, granulated and granules.
(2) Aluminium alloys to B.A. Co., British Standard and special specifications.

F.T.J., 9-2-33.

ALUMINIUM AND LIGHT ALLOYS
THE BRITISH ALUMINIUM Co LTD.
ADELAIDE HOUSE, KING WILLIAM STREET, LONDON. E. C. 4.
TELEPHONE: MANSION HOUSE 5561 & 8074 (5 LINES) TELEGRAMS: CRYOLITE, BILGATE, LONDON.

# Wm. Cumming & Co., Ld.

*Manufacturers of*

CUMMING'S CFF FOUNDRY FACINGS

## FOUNDRY FACINGS

*and*

FINEST PURE

## CEYLON PLUMBAGOS

CUMMING'S CRIC RELIABLE IRON CEMENT

CUMMING'S CCC CORE COMPOUND

CUMMING'S CPP PARTING POWDER

**Quality Reliability Service**

**Head Offices & Works: Kelvinvale Mills, Maryhill, Glasgow, N.W.**
**Branches at Falkirk, Chesterfield, Deepfields and Middlesbrough.**

# WEEKLY PRICE CURRENT.

## COPPER.

| | £ | s. | d. |
|---|---|---|---|
| Standard cash | 28 | 11 | 3 |
| Three months | 28 | 15 | 0 |
| Electrolytic | 32 | 15 | 0 |
| Tough | 30 | 0 | 0 |
| Best selected | 30 | 10 | 0 |
| Sheets | 61 | 0 | 0 |
| India | 41 | 0 | 0 |
| Wire bars | 32 | 17 | 6 |
| Do., March | 32 | 17 | 6 |
| Do., April | 32 | 17 | 6 |
| Ingot bars | 32 | 17 | 6 |
| H.C. wire rods | 35 | 0 | 0 |
| Off. av. cash, January | 28 | 12 | 0⅞ |
| Do., 3 mths., January | 28 | 17 | 10½ |
| Do., Sttlmnt., January | 28 | 12 | 1⅝ |
| Do., Electro, January | 33 | 10 | 3½ |
| Do., B.S., January | 31 | 7 | 6 |
| Do., wire bars, January | 33 | 15 | 8½ |
| Solid drawn tubes | | | 9½d. |
| Brazed tubes | | | 9½d. |
| Wire | | | 6½d. |

## BRASS.

| | |
|---|---|
| Solid drawn tubes | 8¾d. |
| Brazed tubes | 10½d. |
| Rods, drawn | 7¾d. |
| Rods, extd. or rlld. | 4¾d. |
| Sheets to 10 w.g. | 7½d. |
| Wire | 7½d. |
| Rolled metal | 7d. |
| Yellow metal rods | 4½d. |
| Do. 4 × 4 Squares | 5½d. |
| Do. 4 × 3 Sheets | 5¼d. |

## TIN.

| | £ | s. | d. |
|---|---|---|---|
| Standard cash | 148 | 17 | 6 |
| Three months | 149 | 7 | 6 |
| English | 150 | 0 | 0 |
| Bars | 153 | 5 | 0 |
| Straits | 155 | 7 | 6 |
| Australian | 152 | 12 | 6 |
| Eastern | 153 | 10 | 0 |
| Banca | 155 | 12 | 6 |
| Off. av. cash, January | 145 | 15 | 10⅜ |
| Do., 3 mths., January | 146 | 8 | 11½ |
| Do., Sttlmt., January | 145 | 16 | 5½ |

## SPELTER.

| | £ | s. | d. |
|---|---|---|---|
| Ordinary | 13 | 15 | 0 |
| Remelted | 13 | 10 | 0 |
| Hard | 11 | 15 | 0 |
| Electro 99.9 | 16 | 10 | 0 |
| English | 14 | 12 | 6 |
| India | 13 | 10 | 0 |
| Zinc dust | 20 | 15 | 0 |
| Zinc ashes | 2 | 10 | 0 |
| Off. aver., January | 14 | 9 | 9½ |
| Aver. spot, January | 14 | 7 | 7⅞ |

## LEAD.

| | £ | s. | d. |
|---|---|---|---|
| Soft foreign ppt. | 10 | 7 | 6 |
| Empire | 10 | 12 | 6 |
| English | 12 | 0 | 0 |
| Off. average, January | 10 | 12 | 11 |
| Average spot, January | 10 | 9 | 2 |

## ZINC SHEETS, &c.

| | £ | s. | d. |
|---|---|---|---|
| Zinc sheets, English | 24 | 0 | 0 |
| Do., V.M. ex-whse. | 23 | 5 | 0 |
| Rods | 26 | 0 | 0 |
| Boiler plates | 22 | 0 | 0 |
| Battery plates | | — | |

## ANTIMONY.

| | £ | s. | d. | £ | s. | d. |
|---|---|---|---|---|---|---|
| English | 37 | 10 | 0 to | 42 | 10 | 0 |
| Chinese | | | | 27 | 15 | 0 |
| Crude | | | | | — | |

## QUICKSILVER.

| | £ | s. | d. |
|---|---|---|---|
| Quicksilver | 10 | 0 | 0 |

## FERRO-ALLOYS AND STEEL-MAKING METALS.

| | |
|---|---|
| Ferro silicon— | |
| 25% | £8 0 0 |
| 45/50% | £13 15 0 |
| 75% | £19 10 0 |
| Ferro-vanadium— | |
| 35/50% | 12/8 lb. Va. |
| Ferro-molybdenum— | |
| 70/75% carbon-free of Mo. | 6/3 per lb. |
| Ferro-titanium— | |
| 23/25% carbon-free | 10d. lb. |
| Ferro-phosphorus, 20/25% | £17 7 6 |
| Ferro-tungsten— | |
| 80/85% | 1/7½ lb. |
| Tungsten metal powder— | |
| 98/99% | 1/10½ lb. |
| Ferro-chrome— | |
| 2/4% car. | £29 5 0 |
| 4/6% car. | £23 7 6 |
| 6/8% car. | £22 15 6 |
| 8/10% car. | £22 10 0 |
| Ferro-chrome— | |
| Max. 2% car. | £34 17 6 |
| Max. 1% car. | £37 17 6 |
| Max. 0.70% car. | £40 2 6 |
| 70% carbon-free | 1/- lb. |
| Nickel—99.5/100% | £245 to £250 |
| "F" nickel shot | £220 0 0 |
| Ferro-cobalt | 7/3 lb. |
| Aluminium 98/99% | £100 0 0 |
| Metallic chromium— | |
| 96/98% | 2/9 lb. |
| Ferro-manganese (net)— | |
| 76/80% loose | £10 15 0 to £11 5 0 |
| 76/80% packed | £11 15 0 to £12 5 0 |
| 76/80% export (nom.) | £9 15 0 |
| Metallic manganese— | |
| 94/96% carbon-free | 1/4 lb. |

Per ton unless otherwise stated.

## HIGH-SPEED TOOL STEEL.

| | |
|---|---|
| Finished bars, 14% tungsten | 2s. 0d. |
| Finished bars, 18% tungsten | 2s. 9d. |

Per lb. net, d/d buyers' works.

| Extras— | |
|---|---|
| Rounds and squares, 3 in. and over | 4d. lb. |
| Rounds and squares, under ½ in. to ¼ in. | 3d. lb. |
| Do., under ¼ in. to $\frac{3}{16}$ in. | 1/- lb. |
| Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in. | 3d. lb. |
| Do., under ½ in. × ¼ in. | 1/- lb. |
| Bevels of approved sizes and sections | 6d. lb. |

Bars cut to length, 10% extra.

## SCRAP.

| | £ | s. | d. | £ | s. | d. |
|---|---|---|---|---|---|---|
| South Wales— | | | | | | |
| Heavy steel | 2 | 1 | 6 to | 2 | 2 | 6 |
| Bundled steel and shrngs. | 1 | 16 | 0 to | 1 | 19 | 0 |
| Mixed iron and steel | 1 | 16 | 6 to | 1 | 19 | 0 |
| Heavy cast iron | 2 | 4 | 0 to | 2 | 5 | 0 |
| Good machinery | 2 | 7 | 6 to | 2 | 10 | 0 |
| Cleveland— | | | | | | |
| Heavy steel | | | | 2 | 0 | 0 |
| Steel turnings | | | | 1 | 12 | 6 |
| Cast-iron borings | | | | 1 | 3 | 6 |
| Heavy forge | | | | 2 | 10 | 0 |
| W.I. piling scrap | | | | 2 | 2 | 6 |
| Cast-iron scrap | 2 | 0 | 0 to | 2 | 3 | 0 |
| Midlands— | | | | | | |
| Light cast-iron scrap | 1 | 17 | 6 to | 2 | 0 | 0 |
| Heavy wrought iron | | | | 2 | 5 | 0 |
| Steel turnings, f.o.r. | | | | 1 | 2 | 6 |
| Scotland— | | | | | | |
| Heavy steel | | | | 1 | 17 | 6 |
| Ordinary cast iron | 2 | 3 | 6 to | 2 | 6 | 0 |
| Engineers' turnings | | | | 1 | 11 | 6 |
| Cast-iron borings | | | | 1 | 12 | 6 |
| Wrought-iron piling | | | | 2 | 2 | 6 |
| Heavy machinery | 2 | 7 | 6 to | 2 | 10 | 0 |

London—Merchants' buying prices delivered yard.

| | £ | s. | d. |
|---|---|---|---|
| Copper (clean) | 21 | 0 | 0 |
| Brass | 16 | 0 | 0 |
| Lead (less usual draft) | 9 | 0 | 0 |
| Tea lead | 7 | 10 | 0 |
| Zinc | 8 | 0 | 0 |
| New aluminium cuttings | 74 | 0 | 0 |
| Braziery copper | 19 | 0 | 0 |
| Gunmetal | 18 | 0 | 0 |
| Hollow pewter | 80 | 0 | 0 |
| Shaped black pewter | 60 | 0 | 0 |

## PIG-IRON.

*(f.o.t. unless otherwise stated.)*

| | |
|---|---|
| N.E. Coast (d/d Tees-side area)— | |
| Foundry No. 1 | 65/- |
| Foundry No. 3 | 62/6 |
| ,, at Falkirk | 59/9 |
| Foundry No. 4 | 61/6 |
| Forge No. 4 | 61/6 |
| Hematite No. 1, f.o.t. | 59/6 |
| Hematite M/Nos., f.o.t. | 59/- |
| N.W. Coast— | |
| Hem. M/Nos. d/d Glas. | 69/- |
| ,, d/d Birm. | 84/6 |
| Malleable iron d/d Birm. | 115/- |
| Midlands (d/d Birmingham dist.)— | |
| Staffs No. 4 forge | 62/- |
| ,, No. 3 fdry. | 66/- |
| Northants forge | 58/6 |
| ,, fdry. No. 3 | 62/6 |
| ,, fdry. No. 1 | 65/6 |
| Derbyshire forge | 62/- |
| ,, fdry. No. 3 | 66/- |
| ,, fdry. No. 1 | 69/- |
| ,, basic | — |
| Scotland— | |
| Foundry No. 1 | 72/6 |
| ,, No. 3 | 70/- |
| Hem. M/Nos. d/d | 66/- |
| Sheffield (d/d district)— | |
| Derby forge | 59/6 |
| ,, fdry. No. 3 | 63/6 |
| Lincs forge | 59/6 |
| ,, fdry. No. 3 | 63/6 |
| E.C. hematite | 73/6 |
| W.C. hematite | 83/6 |
| Lancashire (d/d eq. Man.)— | |
| Derby forge | 62/- |
| ,, fdry. No. 3 | 67/- |
| Staffs fdry. No. 3 | 67/- |
| Northants fdry. No. 3 | 65/6 |
| Cleveland fdry. No. 3 | 67/- |
| Dalzell, No. 3 (special) | 102/6 to 105/- |
| Glengarnock, No. 3 | 82/- |
| Clyde, No. 3 | 82/- |
| Monkland, No. 3 | 82/- |
| Summerlee, No. 3 | 82/- |
| Eglinton, No. 3 | 82/- |
| Gartsherrie, No. 3 | 82/- |
| Shotts, No. 3 | 82/- |

## FINISHED IRON AND STEEL.

*Usual district deliveries for iron; delivered consumer's station for steel.*

| Iron— | £ | s. | d. | £ | s. | d. |
|---|---|---|---|---|---|---|
| Bars (cr.) | 9 | 0 | 0 to | 9 | 15 | 0 |
| Nut and bolt iron | | | | 7 | 15 | 0 |
| Hoops | 10 | 10 | 0 to | 12 | 0 | 0 |
| Marked bars (Staffs) f.o.t. | | | | 12 | 0 | 0 |
| Gas strip | 10 | 10 | 0 to | 12 | 0 | 0 |
| Bolts and nuts, ¾ in. × 4 in. | | | | 12 | 10 | 0 |
| Steel— | | | | | | |
| Plates, ship, etc. | 8 | 15 | 0 to | 8 | 17 | 6 |
| Boiler plts. | 8 | 0 | 0 to | 9 | 0 | 0 |
| Chequer plts. | | | | 10 | 7 | 6 |
| Angles | | | | 8 | 7 | 6 |
| Tees | | | | 9 | 7 | 6 |
| Joists | | | | 8 | 15 | 0 |
| Rounds and squares, 3 in. to 5½ in. | | | | 9 | 7 | 6 |
| Rounds under 3 in. to ¾ in. (Untested) | 6 | 15 | 0 & up. | | | |
| Flats—8 in. wide and over | | | | 8 | 12 | 6 |
| ,, under 8 in. and over 5 in. | | | | 8 | 17 | 6 |
| Rails, heavy | 8 | 5 | 0 to | 8 | 10 | 0 |
| Fishplates | | | | 12 | 0 | 0 |
| Hoops (Staffs) | 9 | 10 | 0 & up. | | | |
| Black sheets, 24g. (10-t. lots) | | | | 9 | 10 | 0 |
| Galv. cor. shts. ,, | | | | 11 | 15 | 0 |
| Galv. flat shts. ,, | | | | 12 | 5 | 0 |
| Galv. fencing wire, 8g. plain | | | | 14 | 0 | 0 |
| Billets, soft | 4 | 17 | 6 to | 5 | 7 | 6 |
| Billets, hard | 6 | 12 | 6 to | 7 | 2 | 6 |
| Sheet bars | 4 | 15 | 0 to | 5 | 2 | 6 |
| Tin bars | | | | 4 | 15 | 0 |

## PHOSPHOR BRONZE.

| | Per lb. basis. |
|---|---|
| Strip | 10½d. |
| Sheet to 10 w.g. | 11½d. |
| Wire | 11⅜d. |
| Rods | 10½d. |
| Tubes | 16d. |
| Castings | 12½d. |

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

## NICKEL SILVER, &c.

| | Per lb. |
|---|---|
| Ingots for raising | 7d. to 1/1 |
| Rolled— | |
| To 9 in. wide | 1/1 to 1/7 |
| To 12 in. wide | 1/1½ to 1/7¼ |
| To 15 in. wide | 1/1½ to 1/7½ |
| To 18 in. wide | 1/2 to 1/8 |
| To 21 in. wide | 1/2½ to 1/8½ |
| To 25 in. wide | 1/3 to 1/9 |
| Ingots for spoons and forks | 7d. to 1/3½ |
| Ingots rolled to spoon size | 10d. to 1/6½ |
| Wire round— | |
| to 10g. | 1/4½ to 1/11½ |

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

## AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

| | Dols. |
|---|---|
| No. 2 foundry, Phila. | 13.34 |
| No. 2 foundry, Valley | 14.50 |
| No. 2 foundry, Birm. | 11.00 |
| Basic | 15.39 |
| Bessemer | 16.89 |
| Malleable | 16.39 |
| Grey forge | 16.39 |
| Ferro-mang. 80%, seaboard | 68.00 |
| O.-h. rails, h'y, at mill | 40.00 |
| Billets | 26.00 |
| Sheet bars | 26.00 |
| Wire rods | 35.00 |
| | Cents. |
| Iron bars, Phila. | 1.86 |
| Steel bars | 1.60 |
| Tank plates | 1.60 |
| Beams, etc. | 1.60 |
| Skelp, grooved steel | 1.60 |
| Steel hoops | 1.55 |
| Sheets, black, No. 24 | 2.00 |
| Sheets, galv., No. 24 | 2.65 |
| Wire nails | 1.80 |
| Plain wire | 2.10 |
| Barbed wire, galv. | 2.60 |
| Tinplates, 100-lb. box | $4.25 |

## COKE (at ovens).

| | |
|---|---|
| Welsh foundry | 20/- to 22/6 |
| ,, furnace | 16/- to 16/6 |
| Durham and Northumberland— | |
| ,, foundry | 21/- to 25/- |
| ,, furnace | 13/6 to 13/9 |
| Midlands, foundry | — |
| ,, furnace | — |

## TINPLATES.

f.o.b. Bristol Channel ports.

| | |
|---|---|
| I.C. cokes 20×14 per box | 16/- |
| ,, 28×20 ,, | 32/- |
| ,, 20×10 ,, | 23/- |
| ,, 18¾×14 ,, | 16/7½ |
| C.W. 20×14 ,, | 14/- |
| ,, 28×20 ,, | 29/3 to 29/6 |
| ,, 20×10 ,, | 19/10 |
| ,, 18¾×14 ,, | 14/- |

## SWEDISH CHARCOAL IRON & STEEL.

| | |
|---|---|
| Pig-iron | £6 0 0 to £7 0 0 |
| Bars-hammered, basis | £16 10 0 to £17 0 0 |
| Bars and nail-rods, rolled, basis | £15 17 6 to £16 5 0 |
| Blooms | £10 0 0 to £12 0 0 |
| Keg steel | £32 0 0 to £33 0 0 |
| Faggot steel | £18 0 0 to £23 0 0 |
| Bars and rods dead soft, st'l | £10 0 0 to £12 0 0 |

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

## DAILY FLUCTUATIONS.

**Standard Copper** (cash).

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| Feb. | 2 .. | 28 | 10 | 0 | inc. 3/9 |
| .. | 3 .. | 28 | 7 | 6 | dec. 2/6 |
| .. | 6 .. | 28 | 7 | 6 | No change |
| .. | 7 .. | 28 | 8 | 9 | inc. 1/3 |
| .. | 8 .. | 28 | 11 | 3 | .. 2/6 |

**Electrolytic Copper.**

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| Feb. | 2 .. | 32 | 15 | 0 | No change |
| .. | 3 .. | 32 | 15 | 0 | .. .. |
| .. | 6 .. | 32 | 15 | 0 | .. .. |
| .. | 7 .. | 32 | 12 | 6 | dec. 2/6 |
| .. | 8 .. | 32 | 15 | 0 | inc. 2/6 |

**Standard Tin** (cash).

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| Feb. | 2 .. | 150 | 0 | 0 | inc. 30/- |
| .. | 3 .. | 149 | 12 | 6 | dec. 7/6 |
| .. | 6 .. | 149 | 15 | 0 | inc. 2/6 |
| .. | 7 .. | 149 | 12 | 6 | dec. 2/6 |
| .. | 8 .. | 148 | 17 | 6 | .. 15/- |

**Tin** (English ingots).

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| Feb. | 2 .. | 151 | 0 | 0 | inc. 30/- |
| .. | 3 .. | 150 | 15 | 0 | dec. 5/- |
| .. | 6 .. | 150 | 15 | 0 | No change |
| .. | 7 .. | 150 | 15 | 0 | .. .. |
| .. | 8 .. | 150 | 0 | 0 | dec. 15/- |

**Spelter** (ordinary).

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| Feb. | 2 .. | 13 | 11 | 3 | dec. 7/6 |
| .. | 3 .. | 13 | 10 | 0 | .. 1/3 |
| .. | 6 .. | 13 | 13 | 9 | inc. 3/9 |
| .. | 7 .. | 13 | 15 | 0 | .. 1/3 |
| .. | 8 .. | 13 | 15 | 0 | No change |

**Spelter** (Electro, 99.9 per cent.).

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| Feb. | 2 .. | 16 | 10 | 0 | dec. 5/- |
| .. | 3 .. | 16 | 5 | 0 | .. 5/- |
| .. | 6 .. | 16 | 10 | 0 | inc. 5/- |
| .. | 7 .. | 16 | 10 | 0 | No change |
| .. | 8 .. | 16 | 10 | 0 | .. .. |

**Zinc Sheets** (English).

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| Feb. | 2 .. | 24 | 5 | 0 | No change |
| .. | 3 .. | 24 | 0 | 0 | dec. 5/- |
| .. | 6 .. | 24 | 0 | 0 | No change |
| .. | 7 .. | 24 | 0 | 0 | .. .. |
| .. | 8 .. | 24 | 0 | 0 | .. .. |

**Lead** (English).

| | | £ | s. | d. | |
|---|---|---|---|---|---|
| Feb. | 2 .. | 12 | 0 | 0 | No change |
| .. | 3 .. | 12 | 0 | 0 | .. .. |
| .. | 6 .. | 12 | 0 | 0 | .. .. |
| .. | 7 .. | 12 | 0 | 0 | .. .. |
| .. | 8 .. | 12 | 0 | 0 | .. .. |

## AVERAGE MONTHLY PRICES OF RUBIO ORE (MIDDLESBROUGH).

| Year | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Yearly average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. |
| 1895 .. .. | 0 12 0 | 0 12 0 | 0 11 10 | 0 12 0 | 0 12 0 | 0 12 3 | 0 12 3 | 0 12 4 | 0 12 4 | 0 12 6 | 0 12 7 | 0 12 6 | 0 12 2½ |
| 1896 .. .. | 0 12 6 | 0 12 6 | 0 12 9 | 0 12 9 | 0 12 9 | 0 12 7 | 0 12 9 | 0 12 9 | 0 12 9 | 0 13 6 | 0 15 0 | 0 14 9 | 0 13 1 |
| 1897 .. .. | 0 15 3 | 0 15 6 | 0 15 3 | 0 15 0 | 0 14 0 | 0 14 3 | 0 14 3 | 0 14 0 | 0 14 0 | 0 15 0 | 0 14 3 | 0 15 3 | 0 14 8 |
| 1898 .. .. | 0 15 0 | 0 14 4 | 0 14 9 | 0 14 6 | 0 15 0 | 0 15 0 | 0 14 0 | 0 14 0 | 0 14 0 | 0 14 9 | 0 15 0 | 0 14 9 | 0 14 7 |
| 1899 .. .. | 0 15 0 | 0 15 3 | 0 15 6 | 0 15 6 | 0 15 9 | 0 16 0 | 0 17 6 | 0 18 0 | 0 17 9 | 0 18 0 | 0 19 0 | 1 0 0 | 0 16 11½ |
| 1900 .. .. | 1 1 0 | 1 0 6 | 1 1 0 | 1 0 9 | 1 1 0 | 1 1 0 | 1 1 3 | 1 1 6 | 1 1 3 | 1 1 3 | 1 0 0 | 0 18 0 | 1 0 8½ |
| 1901 .. .. | 0 17 6 | 0 16 0 | 0 15 0 | 0 14 6 | 0 15 6 | 0 15 9 | 0 14 9 | 0 15 3 | 0 15 9 | 0 15 9 | 0 15 9 | 0 15 9 | 0 15 7½ |
| 1902 .. .. | 0 15 6 | 0 15 0 | 0 16 0 | 0 16 0 | 0 15 6 | 0 15 3 | 0 15 6 | 0 16 0 | 0 16 0 | 0 16 0 | 0 15 9 | 0 15 6 | 0 15 8½ |
| 1903 .. .. | 0 15 6 | 0 16 0 | 0 16 6 | 0 16 3 | 0 16 3 | 0 16 10 | 0 15 9 | 0 15 6 | 0 15 6 | 0 14 9 | 0 14 9 | 0 15 1 | 0 15 8 |
| 1904 .. .. | 0 14 9 | 0 15 3 | 0 15 1 | 0 15 4 | 0 15 3 | 0 15 0 | 0 14 5 | 0 14 6 | 0 14 6 | 0 14 6 | 0 14 6 | 0 14 7 | 0 14 9½ |
| 1905 .. .. | 0 15 3 | 0 15 6 | 0 15 0 | 0 15 3 | 0 15 6 | 0 15 6 | 0 15 6 | 0 15 6 | 0 16 6 | 0 18 6 | 0 18 9 | 0 18 9 | 0 16 3½ |
| 1906 .. .. | 1 0 0 | 1 1 6 | 1 0 0 | 1 0 0 | 0 19 6 | 1 0 0 | 0 19 6 | 0 19 4 | 1 0 6 | 1 1 6 | 1 1 9 | 1 3 6 | 1 0 7 |
| 1907 .. .. | 1 3 6 | 1 2 6 | 1 2 6 | 1 2 0 | 1 1 6 | 1 2 3 | 1 2 3 | 1 2 0 | 1 1 0 | 0 19 0 | 0 18 9 | 0 17 6 | 1 1 2½ |
| 1908 .. .. | 0 16 6 | 0 15 0 | 0 15 6 | 0 15 6 | 0 15 3 | 0 15 0 | 0 15 0 | 0 14 9 | 0 15 0 | 0 16 0 | 0 16 0 | 0 16 0 | 0 15 5½ |
| 1909 .. .. | 0 15 9 | 0 16 3 | 0 16 0 | 0 16 0 | 0 16 3 | 0 16 6 | 0 16 0 | 0 16 0 | 0 17 0 | 0 17 0 | 0 17 6 | 0 17 6 | 0 16 6 |
| 1910 .. .. | 1 0 4 | 1 0 9 | 1 0 9 | 1 0 9 | 1 0 9 | 1 0 9 | 1 0 9 | 1 0 3 | 1 0 3 | 1 0 6½ | 1 1 3 | 1 1 5 | 1 0 9½ |
| 1911 .. .. | 1 2 2½ | 1 2 6 | 1 2 6 | 1 1 11½ | 1 0 11½ | 0 19 6 | 0 19 0 | 0 19 0 | 0 19 1½ | 0 19 6 | 1 0 0½ | 1 1 6½ | 1 0 7½ |
| 1912 .. .. | 1 2 3 | 1 2 6 | 1 2 6 | 1 1 1½ | 1 1 6 | 1 1 6 | 1 1 6 | 1 2 3 | 1 2 6 | 1 3 0 | 1 3 0 | 1 2 11 | 1 2 2½ |
| 1913 .. .. | 1 2 9 | 1 2 2 | 1 1 7½ | 1 1 6 | 1 0 8½ | 1 0 0 | 1 0 0 | 1 0 0 | 0 19 10½ | 0 19 1½ | 0 19 0 | 0 19 0 | 1 0 5½ |
| 1914 .. .. | 0 18 7½ | 0 18 0 | 0 18 0 | 0 17 9 | 0 17 6 | 0 17 6 | 0 17 1½ | 0 19 7½ | 0 18 11½ | 0 17 10½ | 0 18 7½ | 1 1 0½ | 0 18 5½ |
| 1915 .. .. | 1 7 7½ | 1 8 6 | 1 9 3 | 1 10 2½ | 1 8 6 | 1 6 4 | 1 5 10½ | 1 6 0 | 1 6 10½ | 1 10 8½ | 1 13 0 | 1 17 10 | 1 9 1½ |
| 1916 .. .. | 1 18 6 | 2 0 1½ | 2 2 6½ | 2 0 6½ | 1 15 0 | 1 16 3 | 1 18 0 | 1 18 0 | 1 18 0 | — | — | — | — |
| 1917 .. .. | } Price Fixed | | | | | | | | | | | | |
| 1918 .. .. | | | | | | | | | | | | | |
| 1919 .. .. | — | — | — | — | 2 5 7½ | 2 14 4½ | 2 16 4½ | 2 14 0 | 2 13 4½ | 2 13 0 | 2 12 7½ | 2 11 9 | — |
| 1920 .. .. | 2 17 0 | 3 7 9 | 2 15 6 | 3 6 7 | 3 0 0 | 2 15 0 | 2 14 0 | 2 9 9 | 2 7 6 | 2 11 0 | 2 12 3 | 2 10 0 | 2 15 0 |
| 1921 .. .. | 2 1 0 | 2 0 1½ | 1 18 3 | 1 17 6 | 1 17 6 | 1 17 6 | 1 17 6 | 1 5 0 | 1 8 9½ | 1 7 9 | 1 7 0 | 1 7 0 | 1 13 8½ |
| 1922 .. .. | 1 6 7½ | 1 5 10½ | 1 6 11 | 1 7 0 | 1 7 0 | 1 7 0 | 1 5 3 | 1 4 9½ | 1 4 2½ | 1 3 3½ | 1 2 6 | 1 2 3 | 1 5 2½ |
| 1923 .. .. | 1 2 9½ | 1 4 6½ | 1 5 2 | 1 4 8½ | 1 4 6 | 1 4 0 | 1 3 6 | 1 3 0 | 1 3 0 | 1 3 0 | 1 3 2½ | 1 4 9 | 1 3 10½ |
| 1924 .. .. | 1 4 2½ | 1 4 0 | 1 4 0 | 1 3 7½ | 1 3 8½ | 1 3 6 | 1 2 11 | 1 2 6 | 1 2 1½ | 1 1 7½ | 1 2 3 | 1 2 6 | 1 3 1 |
| 1925 .. .. | 1 2 6 | 1 2 1½ | 1 2 0 | 1 2 0 | 1 2 0 | 1 1 6 | 1 0 6 | 1 0 0 | 1 0 0 | 1 0 0 | 1 0 3 | 1 0 10½ | 1 1 1½ |
| 1926 .. .. | 1 1 1½ | 1 1 6 | 1 1 6 | 1 1 3½ | 1 1 3 | 1 1 5½ | 1 1 6 | 1 1 6 | 1 1 0 | 1 1 6 | 1 1 6 | — | 1 1 4½ |
| 1927 .. .. | 1 2 1½ | 1 2 3 | 1 2 1½ | 1 2 0 | 1 2 0 | 1 2 0 | 1 1 7½ | 1 1 0 | 1 1 0 | 1 1 0 | 1 1 0 | 1 1 0 | 1 1 7½ |
| 1928 .. .. | 1 1 0 | 1 1 1½ | 1 1 11 | 1 2 4½ | 1 2 6 | 1 2 6 | 1 2 6 | 1 2 6 | 1 2 6 | 1 2 6 | 1 2 6 | 1 2 6 | 1 2 2½ |
| 1929 .. .. | 1 2 6 | 1 2 6½ | 1 2 11½ | 1 3 0 | 1 3 0 | 1 3 2½ | 1 4 0 | 1 4 8½ | 1 4 7½ | 1 4 6 | 1 4 6 | 1 4 3 | 1 3 7½ |
| 1930 .. .. | 1 3 3½ | 1 2 6 | 1 1 9 | 1 1 6 | 1 0 10½ | 1 0 0 | 1 0 0 | 0 19 0 | 0 19 0 | 0 17 4½ | 0 16 4½ | 0 16 4½ | 0 19 10½ |
| 1931 .. .. | 0 16 1½ | 0 16 0 | 0 16 0 | 0 15 11½ | 0 15 4½ | 0 15 0½ | 0 14 10½ | 0 14 3½ | 0 14 6 | 0 16 8½ | 0 17 0½ | 0 16 6 | 0 15 9 |
| 1932 .. .. | 0 16 6 | 0 16 6 | 0 16 3 | 0 15 6 | 0 15 4½ | 0 15 0 | 0 14 11 | 0 14 8½ | 0 14 6 | 0 14 6 | 0 14 9 | 0 15 1 | 0 15 3½ |
| 1933 .. .. | 0 15 6 | — | — | — | — | — | — | — | — | — | — | — | — |


# WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

# PIG IRON

REGISTERED TRADE MARKS

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

# NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

# WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

## SITUATIONS VACANT AND WANTED.

BRASS FOUNDRY FOREMAN desires position; experienced in Admiralty contracts, gunmetal, phos. bronze and manganese castings; 12 years foreman in last situation.—Box 258, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EXECUTIVE or good Sales Position wanted by Patentee, with firm willing to take up manufacture of foundry machinery. Good selling proposition.—Box 336, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Foreman desires position, practical and technical training all branches, grey iron, semi-steel, malleable, all non-ferrous metals, and die-casting. Take entire charge foundry and patternshop.—Box 332, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

METALLURGICAL Chemist, aged 40, twenty years with one of Sheffield's most noted steel works, is open for re-engagement; exceptional experience in high-grade alloy steels and their heat treatment.—Apply Box 1,874, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

REQUIRED, Representatives with strong, active connection amongst iron, steel and/or non-ferrous foundries in any localities throughout U.K. New Refractory of guaranteed regular quality available; unlimited supply. Very substantial commission basis; merchant firms can apply to sell on merchant basis.—Write, Box 322, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, for India, Foreman Wood Pattern Maker, for general work; age about 30; five years' engagement; commencing salary Rs. 500 per month, with free unfurnished quarters and passage out and home.—Applications, stating age, experience, etc., to be addressed to "PATTERN MAKER," c/o Advertisement Dept., 5, New Bridge Street, London, E.C.4.

WORKING Foundry Foreman wanted for Midland Jobbing Iron Foundry with 2-3 moulders, experienced in most economical working until trade revival; very reasonable wages. Give full particulars.—Box 334, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

## BUSINESS FOR SALE.

OLD-ESTABLISHED FOUNDRY at Crook, in the County of Durham; goodwill; founded 1847; including moulding shop with lean-to, fitting, blacksmith and pattern shops, offices and stores, stabling, hayshed and outbuildings, covering 2½ acres, with full plant and machinery; rated £9 and industrial hereditament and suitable for expansion or adaptation; ADJOINING RAILWAY and MAIN ROAD. Also substantial Stone-built Dwelling-house containing 9 rooms with outbuildings and large garden, rated £15; gas and electricity laid on. To be sold as a whole or separately.—Box 328, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

## PROPERTY.

MAGNIFICENT

**11 ACRES WORKS SITE.**

**SHEFFIELD.**

**145,000 Sq. Ft. of Shops.**

**SIDING CONNECTIONS**

**with L.M. & S. and L. & N.E. Rlys.**

**WELL-BUILT & COMMODIOUS OFFICES**

**Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.**

Apply—

**THOS. W. WARD, LTD.,**

**ALBION WORKS, SHEFFIELD.**

## AGENCY.

FOUNDRY Engineer, with excellent Midland Counties connections, is open to consider a further Agency for Moulding Machines or Sand-blast Plant for foundry or other purposes, etc.—Box 330, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

## AUCTION SALE.

SALE ON THURSDAY AND FRIDAY, FEBRUARY 16 and 17, at 10.30 a.m. each day. ON VIEW WEDNESDAY, FEBRUARY 15, 10 to 4.30.

By Order of MR. T. FAWLEY-JUDGE, the Liquidator of Stones, Wilkinson & Company, Limited, at the

KING STREET BRASSWORKS,
Market Place, Hull,

The Whole of the Fixed and Loose
MACHINERY AND PLANT,

comprising 10-h.p. Crossley Gas Engine, Power and Hand Lathes, Hand-Shearing Machine, Testing Pump, Buffing Machine, Radio Drilling Machine, Emery Grinder, Magnetting Machine, 2 Shaping Machines, Tube-Screwing Machine, Anvil, Shafting and Pulleys.

STOCK-IN-TRADE,

including Gunmetal Steam Fittings and Castings, Plumbers' Sanitary Brasswork, Four-pull Beer Engine, Beer Pumps, Valves and Taps, Closet Seats, Wash Bowls, Copper and Brass Tubing, Foundry and other Tools, Benches and Vices, about 4½ tons of Moulding Sand, Coke and Firewood, 2 Handcarts, and OFFICE FURNITURE, consisting of 4 Safes, Showcases, etc., appertaining to the trade of Brass Founders and Finishers, as carried on at the premises for many years past, will be SOLD BY AUCTION on the premises as above, by N. EASTON & SON.

Catalogues may be obtained from the AUCTIONEERS, Imperial Chambers, Bowlalley Lane, Hull (Tel.: 35645 Hull), or FAWLEY-JUDGE & EASTON, Chartered Accountants, Parliament Street, Hull.

## MACHINERY.

### SAND BLASTING PLANTS FOR SALE

Tilghman Sand Blast Room, 6 ft. x 6 ft. x 8 ft. high.

Tilghman Rotary Barrel, 36 in. x 30 in.

Tilghman Rotary Double Barrel Plant, barrels 24 in. x 20 in.

Tilghman 4-ft. 6-in. x 3-ft. Cabinet Plant.

Tilghman 30-in. dia. Cabinet Plant.

Jackman Rotary Barrel, 30 in. x 24 in.

Each Plant complete with Sand Apparatus, Air Compressor and Exhaust Fan.

Large stock of FOUNDRY PLANT at LOW PRICES.

**S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.**

215, BARCLAY ROAD, WARLEY,
Nr. Birmingham.

'Phone: Bearwood 1103.

**THOS. W. WARD, LTD.**

COLD SAWING MACHINE, Circular, Heller, 48" dia. blade.

SHAPING MACHINE, 17/19" str., centralised control, Pillar type.

GENERATING SET, 20 kw., petrol dr., 4 cyl., 110 v., 750 revs.

2 MARINE BOILERS, 15' x 11' 6", 120 lbs. w.p.

*Write for "Albion" Catalogue.*

'Grams: "Forward, Sheffield."
'Phone: 23001 (10 lines).

ALBION WORKS, SHEFFIELD.

## PUBLICATION

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. 1932 edition. Price 42s., bound in cloth.—INDUSTRIAL NEWSPAPERS, LTD., 49, Wellington Street, Strand, London, W.C.2.

## MISCELLANEOUS.

SPRIGS (fine cut) at cut prices; 3 in. to 6 in., £11 10s. ton d/d any station England, or 11s. 6d. cwt., carriage extra.

Inquiries esteemed.

ROBERTS METALLURGICAL COMPANY,
30, Ravenswood Road, Balham,
London, S.W.

'Phone: 287 SLOUGH

### HAND MOULDING MACHINES

Six Standard "Adaptable" machines £12 each
Two "LARGE" Adaptables (take 30"×30") ... ... £15 each
24"×30" Darling & Sellars turnover £15
Two 18"×16" Coventry HEADRAM squeezers ... ... £18 each

### PNEUMATIC MACHINES

14"×16" Tabor split pattern ... £30
18"×18" Tabor split pattern ... £40
30"×20" Macdonald jolt rollover... £60
20"×16" Macdonald jolt rollover... £40

**AIR COMPRESSORS**
**ALL SIZES IN STOCK.**

*Every Machine overhauled and retested.*

***BUY FROM ME AND SAVE MONEY!***

**ALEX. HAMMOND,** *Foundry Machinery Merchant,*
**14, AUSTRALIA ROAD, SLOUGH**

To Engineers, Founders, Manufacturers. Fine site of nearly 3 acres on Arterial Road with Foundry and Workshops and own Rail Sidings into premises. Modern Offices, Warehouse and Workrooms. Central Heating.

CHARLES A. TRICKS & SON,
Auctioneers,
ST. NICHOLAS STREET, BRISTOL.

### FOUNDRY REQUISITES

**SPECIALITIES, REFRACTORIES, EQUIPMENT Etc., Etc.**

| | | |
|---|---|---|
| Core Oils | Fluxes | Parting Powders |
| Compounds | for | Plumbagoes |
| Binders | Iron | Graphites |
| Core Gum | Steel | Coal Dust |
| Chaplets | Brass | Blackings |
| and Studs | Bronze | Ladles, Bellows |
| Moulders' Pins | Gunmetal | Sieves, Riddles |
| Sprigs, Nails | Aluminium | Wire Brushes |
| Core Wire | Etc., Etc., | Barrows, Shovels |

**Refractories of every description**

EVERYTHING IN FOUNDRY EQUIPMENT

### BRITISH FOUNDRY UNITS

*Incorporating* LTD.
**Foundry Materials & Products Dept. of BEECROFT & PARTNERS, LTD.**
*Incorporating*
**Foundry Requisites & Chesterfield Blacking Works of J. & J. DYSON, LTD.**
**RETORT WORKS,**
**CHESTERFIELD.**

Telegrams: RETORT, CHESTERFIELD. Telephone: 2719 CHESTERFIELD